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Soil Report

Patrick Project

**Whitman District, Wallowa-Whitman National Forest
Baker County, Oregon**

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A handwritten signature in blue ink, appearing to read "Mary Young".

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INTRODUCTION

The long-term sustainability of forest ecosystems depends on the productivity and hydrologic functioning of soils. Ground-disturbing management activities directly affect soil properties, which may adversely change the natural capability of soils and their potential responses to use and management. Forest soils are considered to be a non-renewable resource, as measured by human life spans, and maintenance or enhancement of soil productivity is an integral part of National Forest Management. The following section documents the soil resource effects of the proposed Patrick Project. Specific management indicators to be analyzed include soil productivity, erosion potential, and soil stability. The report will analyze soil types within activity areas, their limitations, and offer methods that may allow for mitigation of limiting characteristics for a given soil or activity area.

Forest Service Manual 2520 Region 6 Supplement 2520-98-1 provides direction for the management of soils within activity areas in order to meet direction in the National Forest Management Act of 1976 and other legal mandates (Appendix A). NFMA directs the Forest Service to manage National Forest System lands under ecosystem management principles, without permanent impairment of land productivity and to maintain or improve soil and water quality. The R6 soil quality standards set thresholds beyond which soil quality is considered to be adversely impacted. A minimum of 80% of an activity area must be left in an acceptable soil quality condition.

This analysis utilizes the best available soil survey mapping for the Wallowa-Whitman National Forest (NF). It is important to note that soil surveys are constantly evolving and changing, as is science. Landtype associations (LTAs) were also used in this analysis, and are based on vegetation zones, geology groups, and landforms (USDA Forest Service, 2006). The general use for LTA data is forest or area-wide planning and watershed analysis, appropriate for the scale of this project.

A suite of Best Management Practices (BMPs) and Project Design Criteria (PDC) will be integrated into the design of alternatives and the analysis of effects to ensure that relevant natural resources are managed and protected in a manner consistent with policy, law, and regulation. BMPs and PDCs will also serve to ensure that implementation of the actions described in the Decision Notice are properly executed.

RELEVANT LAWS, REGULATIONS, AND POLICY

REGULATORY FRAMEWORK

Land and Resource Management Plan

The Wallowa-Whitman National Forest Land and Resource Management Plan (LRMP) provides standards and guidelines for the soil resource (Wallowa-Whitman LRMP 4-21).

Goal: To maintain or enhance soil productivity

Standards and Guidelines:

- **Conflicts with Other Uses.** Give maintenance of soil productivity and stability priority over uses described or implied in all other management direction, standards, or guidelines. Exceptions may occur for such things as campgrounds or transportation facilities when it is determined, through environmental analysis, to be in the public interest.
- **Protection.** Minimize detrimental soil conditions with total acreage detrimentally impacted not to exceed 20 percent of the total acreage within the activity area including landings and system roads. Where detrimental conditions (see glossary) affect 20 percent or more of the activity area,

restoration treatments will be considered. Detrimental soil conditions include compaction, puddling, displacement, and severe burning

- Give special consideration to scablands or other lands having shallow soils during project analysis. Such analysis will especially consider the fragile nature of the soils involved and, as necessary, provide protection and other mitigation measures.
- Use approved skid trails, logging over snow or frozen ground, or some equivalent system for limiting the impact and areal extent of skid trails and landings and to prevent cumulative increases from multiple entries in tractor logging areas.
- Re-establish vegetation following wildfire or management activities where necessary to prevent excessive erosion.

Federal Law

Organic Administration Act of 1897 (16 USC 473-475)

The Organic Administration Act of 1897 authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests "...to improve and protect the forest within the boundaries, or for the purposed of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

Bankhead Jones Farm Tenant Act of 1937

The Bankhead-Jones Farm Tenant Act of 1937 authorizes and directs a program of land conservation and land utilization, in order to correct maladjustments in land use, and thus assist in controlling soil erosion, preserving natural resources, mitigating floods, conserving surface and subsurface moisture, protecting the watershed of navigable streams, and protecting the public lands, health, safety, and welfare.

Knutson-Vandenberg Act of 1930

In addition, NFMA amends section 18 of Knutson-Vandenberg Act (KV). This amendment authorizes the use of KV funds to protect and improve the future productivity of the renewable resources of the National Forests, including soil and water. This project will prioritize KV funds for rehabilitation of temporary roads created on non-system historic road templates that are only required to be returned to existing condition after use (Soil PDC 14).

Multi-Use and Sustained Yield Act of 1960

The project, with described mitigation and BMPs in place, would meet the intent and direction of the Multi-Use Sustained Yield Act of 1960. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

National Forest Management Act of 1976 (NFMA) 16 USC 1604(g)(3)(i)

This project complies with NFMA 16 USC 1604 (g)(3)(i), which requires that project activities do not produce substantial and permanent impairment of the productivity of the land. Additionally, NFMA requires that timber will be harvested from National Forest System lands only where soil, slope or other watershed conditions will not be irreversibly damaged.

36 CFR 219.20

The project complies with 36 CFR 219.20, which requires conservation and protection of soil and water resources.

Other Guidance or Recommendations

Pacific Northwest (R6) Supplement 2500-98-1 (Regional Soil Quality Standards)

The Region 6 Soil Quality Standards found in FSM 2500 Supplement 2500-98-1 (USDA Forest Service, 1998), provide soil quality standards to assure the statutory requirements of NFMS Section 6(g)(3)(i) are satisfied. These soil quality standards protect the “productivity of the land” by setting limits for the degree of detrimental soil conditions. The R6 supplement specifies that at least 80% of an activity area (defined as land area affected by a management activity, including landings and system roads) have soil that is in an acceptable soil quality condition. In other words, detrimental impacts (including past management impacts) shall be less than 20% of an activity area. In areas where less than 20% detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 20%. In areas where more than 20% detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration must, at a minimum, not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.

TOPICS AND ISSUES ADDRESSED IN THIS ANALYSIS

RESOURCE INDICATORS AND MEASURES

Table 1. Resource indicators and measures for assessing soil effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Soil Productivity	Detrimental Soil Conditions	Acres of detrimental soil conditions	No	LRMP, FSM, NFMA, Multi-Use Sustained Yield Act
	Droughty Soils	Acres of droughty soil types proposed for treatment		
Soil Erosion	Erosion Potential	Tons/acre of hillslope erosion modeled from WEPP		
		Acres of proposed treatment activities on soils with high surface erosion hazard		
		Miles of temporary roads on high erosion potential soil		
Slope Stability	Landslide Potential	Acres of proposed treatment activities on landtypes with high landslide potential		
		Miles of temporary roads on landtypes with high landslide potential		

Soil Productivity

1. Acres of previously harvested areas proposed for treatment
2. Acres of droughty soil types proposed for treatment

Soil productivity is a key factor to maintaining ecosystem function (Powers et al., 1998). Soil productivity is defined as the ability of the soil to supply the water and nutrients needed to sustain plant growth. Variables that influence soil productivity include physical soil characteristics, organic matter and soil biological activity. Past management activities in the analysis areas likely have caused Detrimental Soil Conditions (DSC) and impacted soil productivity. According to Region 6 Soil Quality Standards, detrimental soil conditions (e.g., compaction, displacement, puddling, severe burning, and erosion) from management activities should not exceed 20% of an Activity Area, including landings and system roads. Soil quality guidelines also include retention of soil organic matter, coarse woody material, and maintenance and protection of soil moisture regimes. Soil disturbance effects on productivity are dependent on the degree, extent, distribution, and duration of the effects (Clayton et al., 1987; Craig and Howes, 2007; Froehlich, 1976; Snider and Miller, 1985). The degree and duration of soil disturbance effects are largely determined by inherent soil properties, such as texture, coarse-fragment content, or organic matter content. Extent, distribution, and, in some instances, degree of soil disturbance can be controlled by management constraints, such as changing the season of operation, spacing of skid roads, and the number of equipment passes (Page-Dumroese et al., 2009).

Many dry forest landscapes in the Blue Mountains can be found on soils unable to sustainably support current vegetation densities based on soil properties. Forested conditions on these droughty soils make stands susceptible to increased insect infestation, disease, and wildfire due to drought conditions. Reducing unsustainable vegetation densities will increase soil productivity by increasing available water and nutrients needed to sustain plant growth.

Physical Soil Characteristics

Physical soil characteristics include soil depth, porosity and bulk density. Changes in these occur most often when ground-based equipment makes repeated passes over the soil (Lull, 1959). These activities compact soils and if soils are moist enough, cause rutting and puddling. All of these changes to the physical soil characteristics reduce the pore space volume and water holding capacity. These physical changes reduce infiltration rates, slow soil drainage, impede root growth and reduce plant-available water and nutrients. Physical soil disturbances also decrease gas exchange, affecting both plants and soil biota. Some physical changes to soil characteristics are classified as detrimental soil conditions (DSC), which are often found in higher impacted areas. Regional soil quality standards define the thresholds beyond which soil quality is adversely impacted (See methodology section below).

Organic Matter

Organic matter in its various forms is critical for long-term site productivity and ecosystem sustainability. Regional direction states it should be maintained in amounts sufficient to prevent short or long-term nutrient and carbon cycle deficits and to avoid detrimental physical and biological soil conditions. Organic matter is particularly important for water retention, cation exchange, nutrient cycling, and erosion control (Powers et al., 2005). Humus is decomposed organic matter. Duff and litter are partially decomposed leaves, needles and twigs less than three inches in diameter on the soil surface. In most coniferous trees, 85 to 90 percent of the total nutrients are contained in branches, twigs and foliage (Garrison et al., 1998). Coarse woody debris consists of woody stems greater than three inches in diameter and is essential to maintaining soil productivity (Harvey et al., 1994; Graham et al., 1994). This material has no effect on soil nitrogen or other nutrients regardless of decay stage and it can compete with vegetation for limited nutrients through immobilization (Busse, 1994; Prescott et al., 2002). Studies of post-harvest and site preparation activities showed that loss of organic matter can reduce soil productivity by changing soil physical, chemical and biological properties (Perry et al., 1989; Powers et al., 1990; Dyck et al., 1994; Everett et al., 1994; Harvey et al., 1994; Henderson, 1995; Jurgensen et al., 1997).

Soil Biological Activity

Soil organisms, including fungi and bacteria, drive the nutrient cycling process by decomposing organic matter and mineralizing nutrients for use by plants. Soil organisms depend on organic matter for the nutrients they need to carry out their life processes. Decomposed large woody debris provides habitat for the survival of mycorrhizae fungi. These fungi form a symbiotic relationship with tree roots, increasing water and nutrient uptake by the trees and the fungi (Borchers and Perry, 1990).

Soil Erosion

1. Tons/acre of hillslope erosion modeled from WEPP
2. Acres of proposed treatment activities on soils with high surface erosion hazard
3. Miles of temporary roads on high erosion potential soil

Surface erosion is defined as the detachment and transport of soil particles by running water, waves, currents, moving ice, wind, or gravity. The main types of surface erosion are sheet, rill, and gully erosion (Brady and Weil, 2007). In sheet erosion, soil is removed more or less uniformly from the ground surface by raindrop splash. As this overland flow is concentrated, small channels develop (rills), and rill erosion occurs. Gully erosion results when the volume of water is further concentrated. The force of water cuts deeper into the soil, enlarging rills into larger channels termed gullies. Surface erosion is most serious on bare, non-vegetated soils surfaces where sheet and rill erosion are responsible for most soil loss. Erosion is infrequent on undisturbed forest soils for two reasons:

- a) Abundant organic matter provides a protective layer on the soil surface that reduces the impacts of raindrops and allows water to infiltrate; and
- b) The surface soil below the organic layer is by nature porous, allowing water to infiltrate into and through the soil profile (Goldman et al., 1986).

Soil erosion can occur when the surface soil is compacted or when the loose surface soil and its protective layer of organic material are changed by management activities. Compaction, rutting and puddling reduce the movement of water into the soil and tend to channel and concentrate water. As a result, run off (overland flow) is increased and carries soil particles with it. If the forest floor is disturbed, then runoff and erosion rates can increase by several magnitudes. Disturbance can be natural, such as wildfire, or human-induced, such as harvesting or prescribed burning for ecosystem management. When organic matter is removed, soil pores can be plugged by impact from raindrops resulting in overland flow and increased rates of soil erosion. Soil erosion can result in loss of soil productivity due to surface soils moving downslope and thus removing the materials with the greatest ability to hold moisture and nutrients. According to Region 6 Soil Quality Standards, for planning or implementation monitoring to meet acceptable levels of soil loss and soil management objectives, the minimum percent effective ground cover following cessation of any soil-disturbing activities is found in Table 2.

Table 2. Region 6 Soil Quality Standard for Minimum Percent Effective Ground Cover

Erosion Hazard Class	Minimum Percent Effective Ground Cover	
	1st Year	2nd Year
Low (Very slight-slight)	20-30	30-40
Medium (Moderate)	30-45	40-60
High (Severe)	45-60	60-75
Very High (Very Severe)	60-90	75-90

Effective ground cover is defined as the basal area of perennial vegetation, plus litter and coarse fragments (greater than 2mm sizes), including tree crowns and shrubs that are in direct contact with the ground. Exceptions may occur where specific projects meet erosion control objectives without meeting the ground cover objectives stated above.

Slope Stability

1. Acres of proposed treatment activities on landtypes with high landslide potential
2. Miles of temporary roads on areas with high landslide potential

Mass wasting is the downslope movement of large mass of unstable soil, rock, and other debris due primarily to the forces of gravity (Brady and Weil, 2007; Brooks et al., 1997). Mass wasting can be caused by man-made disturbances or natural events, such as wildfire followed by high-intensity precipitation. Some areas are prone to mass failures because of the nature of the bedrock geology or soil (Vallier, 1995). There are a wide variety of types of mass wasting events, but the ones of most concern are debris avalanches (including debris torrents and flows) and landslides. Other types of mass wasting events occur, but these two general categories account for the greatest impacts. Debris avalanches involve the rapid movement of soil, rock, and organic debris in stream channels or dissections because of saturated soils, high stream flows, or other upslope mass movements. If the material is primarily saturated soil, it may liquefy and move as a mudflow. Landslides occur with a sudden shear failure and downhill movement of soil and/or rock materials, usually under very wet conditions, as a result of over steepening and the reduction of internal friction.

Management activities can saturate a soil by channeling water and concentrating it onto a limited area, for example, below a road culvert or a rutted skid trail. All mass failures triggered by human causes are classified as DSC. These disturbances cause long-term changes in soil productivity that can last centuries.

METHODOLOGY

INFORMATION SOURCES

Evaluation of Soil Productivity

The gridded Soil Survey Geographic (gSSURGO) Database was used to determine the types of soils present within the project area. The soil survey was field verified throughout the summer of 2018 and no changes were made to the survey. The soil survey classifications allow soils to be grouped to permit the largest number and the most precise predictions possible about responses to use and management (USDA

Natural Resource Conservation Service, 2017). This system allows for monitoring results from one taxonomic unit to be related to other, similar taxonomic units. Soil survey data was used to identify droughty soil properties. The soil survey was also used to identify sensitive soils which include volcanic ash-capped soils, clay soils, udic (moist) soils, hydric soils, low productivity soils, and shallow soils.

The Forest Service Activity Tracking System (FACTS) data was used to identify past timber harvest information in order to evaluate existing conditions. Past harvest history was used in conjunction with field observations during the summer of 2018 to evaluate existing detrimental soil conditions (DSCs). This provided an understanding of soil productivity within activity areas, and how past activities may have influenced the soil resource. Field soil surveys were conducted using the Forest Soil Disturbance Monitoring Protocol (FSDMP), and R6 Soil Quality Standard definitions to determine DSC. Detrimental soil conditions are defined as:

○ Detrimental Compaction

- Volcanic Ash/Pumice Soils (Soils with Andic Properties). An increase in soil bulk density of 20 percent, or more, over the undisturbed level.
- Other Soils. An increase in soil bulk density of 15 percent, or more, over the undisturbed level, a macropore space reduction of 50 percent or more, and/or a reduction below 15 percent macro porosity.

Assess changes in compaction by sampling bulk density, macro porosity, or penetration resistance in the zone in which change is relatively long term and that is the principal root development zone. This zone is commonly between 4 to 12 inches in depth.

- Detrimental Puddling. Detrimental puddling is when the depth of ruts or imprints is six inches or more. Soil deformation and loss of structure are observable and usually bulk density is increased.
- Detrimental Displacement. Detrimental displacement is the removal of more than 50 percent of the A horizon from an area greater than 100 square feet, which is at least 5 feet in width.
- Detrimental Burned Soil. Soils are considered to be detrimentally burned when the mineral soil surface has been significantly changed in color, oxidized to a reddish color, and the next one-half inch blackened from organic matter charring by heat conducted through the top layer. The detrimentally burned soil standard applies to an area greater than 100 square feet, which is at least five feet in width.
- Detrimental Surface Erosion. For effectiveness monitoring, detrimental erosion is visual evidence of surface loss in areas greater than 100 square feet, rills or gullies and/or water quality degradation from sediment or nutrient enrichment. (See FSM 2532)

For planning or implementation monitoring to meet acceptable levels of soil loss and soil management objectives, the minimum percent effective ground cover following cessation of any soil-disturbing activity should be:

Erosion Hazard Class	Minimum Effective Ground Cover	
	1st Year	2nd Year

Erosion Hazard Class	Minimum Effective Ground Cover	
Low	20-30%	30-40%
Medium	30-45%	40-60%
High	45-60%	60-75%
Very High	60-90%	75-90%

The above erosion hazard classes are from Soil Resource Inventories, ecological unit inventories, the Region 5 Erosion Hazard Rating System (R5-2500-14) and locally adapted standard erosion models and measurements.

- **Detrimental Soil Mass Wasting.** Detrimental mass wasting is visual evidence of landslides associated with land management activities and/or degrades water quality. (See FSM 2532)

Plan activities to avoid acceleration of natural landslide rates. Make Level I, II, or III stability analyses as appropriate. (Ref. USDA FS EM-7170-13 Vol. 1-3)

Field FSDMP surveys were completed 9/3/2018 – 9/7/2018. It should be noted that estimated values for DSCs are not absolute and are best used to describe the existing soil condition. The calculation of the percentage of additional DSCs from a given activity is an estimate, since DSCs depend on a combination of factors such as existing ground cover, soil texture, timing of operations, equipment used, skill of the equipment operator, the amount of wood being removed, and sale administration. The DSC estimates of proposed activities also assume that BMPs will be implemented, and that soil recovery occurs over time. In order to ensure feasibility during implementation, only units requiring over an acre (when rounded) of rehabilitation will be listed for rehabilitation.

Predicted DSCs from proposed temporary road and non-system road prisms are calculated based on average clearing width. Temporary and non-system road prisms are part of the productive land base as defined by NFMA Section 4 through 7, and therefore, predictions of potential impacts on soil productivity are required. All temporary roads and non-system roads are estimated to average 12 feet in width of total disturbance resulting in 1.5 acres of DSC per mile. All associated impacts from temporary road construction and closure are assigned to the related harvest units.

For existing condition analysis, Activity Areas (i.e., a spatial boundary with the same proposed activities) were established, as defined in R6 Soil Quality Standards and Guidelines. In this report, activity areas in reference to unit numbers found in proposed action data.

Soil Erosion Potential

The gSSURGO data and interpretations from the National Forestry Manual were used to evaluate erosion potential off-road and off-trail, as well as road and trail erosion potential (USDA NRCS, 2004). Potential erosion ratings were determined by combining the effects of slope, soil erodibility factor Kw (whole soil), and content of rock fragments. The K-factor quantifies the susceptibility of soil particles to detachment and movement by water including the effects of rainfall, runoff, and infiltration. Values of K range from 0.02 to 0.69, and the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

The off-road and off-trail erosion ratings assess and assume:

- Sheet and rill erosion from exposed soil surfaces caused by various silvicultural practices, grazing, fire, and firebreaks,
- Activities that disturb the site resulting in 50 to 75 % exposed mineral surface layer in the affected area,
- And the use of any equipment type or size.

Off-road and off-trail erosion ratings indicate the hazard or risk of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. Soils with “severe” ratings are very likely to have erosion, control measures for vegetation re-establishment on bare areas and structural measures are advised on these soils. Soils with “very severe” ratings are expected to have significant erosion is expected, loss of soil productivity and off-site damages are likely, and control measures are costly and generally impractical on these soils.

The road and trail erosion ratings assess and assume:

- The forces that natural precipitation events have to dislodge and move soil materials on roads, trails, and firebreaks,
- Activities on roads and trails that result in bare ground, compaction, and reshaping of the soil surface
- Use of trucks, skidders, off-road vehicles, and other similar equipment,
- The impact on compacted, bare road, trail surface using the representative value for slope gradient,
- Roads and trails are generally linear, continuous, and narrow ranging up to 7.5 meters in width.

Soils with a “severe” rating are expected to have significant erosion, roads will require frequent maintenance, and costly erosion control measures will be needed.

The Water Erosion Prediction Project (WEPP) model was used to predict hillslope erosion for all alternatives. The WEPP erosion model is a process-based, continuous simulation erosion prediction model that simulates hillslope rill, interrill erosion processes, hydrologic and erosion processes on small watersheds. The model considers the spatial and temporary variability in topography, surface roughness, soil properties, and land use conditions on hillslopes. Data inputs to WEPP included:

- Parameter-Regression on Independent Slope Model (PRISM) modified Austin Climate Station with 45 years of climate records,
- Slope data from the US Geological Survey (USGS) Digital Elevation Model (DEM),
- SSURGO soil data,
- Landcover from USGS National Landcover dataset. The landcover was adjusted from untreated conditions to treated conditions using Disturbed WEPP provided ground cover assumptions.

It should be noted that the use of PRISM data allowed for modification of Austin Junction Climate Station data in order to more closely match the climate within the project area. The model was run once to

calculate baseline hillslope erosion, and once to calculate hillslope erosion after thinning and prescribed fire. The model generates the mean annual average soil loss for each watershed modeled, which is averaged from the average of each hillslope within the watershed. Return Period Analysis is also generated, which provides probabilities of erosion rates in the first year following treatments given a range of precipitation scenarios, represented as precipitation return intervals (e.g., 2 tons of erosion if a 30-year precipitation event occurs during the first year following treatment).

Slope Stability

The Landtype Associations (LTA) of Blue Mountains Ecoregion was used to determine slope stability. The LTA's of Blue Mountains Ecoregion is an ecological inventory that identifies similar physical and biological processes across the landscape (USDA, 2006; USDA, 1993). Factors used to classify landtypes with landslide potential include:

- Easily weathered bedrock high in minerals weathering to clay,
- geologic structural features such as folding, faulting, and/or interbedded strata,
- geomorphic shape features (escarpments and converging concave topography),
- fine textured surficial deposits, slope gradients greater than 20 percent, indications of concentrated ground water, and
- indications of surface and subsurface water.

Landtype Associations with high landslide probability have most of the properties listed above. Evidence of landslides have been observed over most of the area within these landtypes. And the degree of limitation generally requires major reclamation, special project design, or intensive maintenance (USDA, 2006). The relative potential of movement and location varies depending on whether the landslides are ancient features with only unstable margins along active stream courses, dormant features having a higher likelihood of movement when in contact with water tables, or actively moving features (USDA, 2006). Existing landslide areas were also identified using LiDAR imagery. Level 1 Slope Stability Assessment was conducted in the field with geotechnical engineers on June 5th, 2019 (Prellwitz et al., 1994). Their observations and recommendations will be included in this report, project design features, and project record.

SCIENTIFIC UNCERTAINTY AND CONTROVERSY

Site and soil productivity rely on complex chemical, physical, and climatic factors that interact within a biological framework. For any given site and soil, a change in a key soil variable (e.g., bulk density, soil loss, and nutrient availability) can lead to changes in potential soil productivity. Defining the threshold at which productivity is detrimentally disturbed is controversial. The rationale for the 15% limit of change in soil bulk density was largely based on the collective judgment of soil researchers, academics, and field practitioners, and the accepted inability to detect changes in productivity less than 15% using current monitoring methods (Powers, 1990). Note that volcanic ash and pumice soils, have a 20% limit of change in soil bulk density due to inherently low soil bulk density. Powers (1990) states that the soil quality guidelines are set to detect a decline in potential productivity of at least 15%. This statement does not mean that the Forest Service tolerates productivity declines at this level, but that it recognizes problems with detection limits.

Soil quality standards are being studied by a cooperative research project called the North American Long-Term Soil Productivity Study (LTSP). The 5- and 10-year results were recently published (Page-Dumroese et al., 2006; Fleming et al., 2006; Sanchez et al., 2006). The LTSP study is ongoing and

provides the best available science to resource professionals. In a 10-year study, no observed reduction in tree growth occurred as a result of compaction or organic matter removal in plots with soils generally similar to those found in the project area (silt loam) (Powers et al. 2005). These results are relatively short-term and involve many site- and soil-specific factors. Future results from the ongoing study should be helpful for assessing harvest practices on soil productivity.

Additional controversy surrounds the use of the term “irreversible” in the NFMA. The NFMA has guidelines that “insure that timber will be harvested from NFS lands only where soil, slope, or other watershed conditions will not be irreversibly damaged.” The DSC described in this analysis does not necessarily result in substantial and permanent impairment. Detrimental soil conditions are reversible if the processes (organic matter accumulation, moisture, topsoil retention, and soil biota) are in place and if time is allowed for recovery. Loss of the volcanic ash cap could occur through erosion or removal by excavation for temporary roads and/or skid trails. Recovery from damage and/or loss of ash could still occur in the remaining subsurface and volcanic ash soils. Under Alternatives 2 and 3, loss of ash cap soils wouldn’t be substantial and would be mitigated through BMPs and PDCs to limit harvest activities to occur under dry or frozen conditions and to pull topsoil back over any disturbed surface to prevent permanent loss of productivity.

SPATIAL AND TEMPORAL CONTEXT FOR EFFECTS ANALYSIS

The analysis area forms the boundary for the direct, indirect, and the cumulative effects in this soil analysis. It consists of the proposed actions within each analysis area. This analysis area was selected because it is where the effects of implementing the proposed activities would occur. The effects on soils would not extend beyond the analysis areas proposed for treatment. Natural and human-induced erosional processes may transport detached soil to a new location, if this occurs it is unknown if some portion of this material will end up outside of the project boundary.

The temporal boundaries for analyzing effects start from the initiation of historic forest activities, because soil disturbance can remain on the landscape for many decades. Short-term impacts are considered to be within 15 years and long-term effects being those that last for more than 15 years. Effects that are eliminated by the natural course of a single growing season are not considered effects because they are so short lived.

AFFECTED ENVIRONMENT

EXISTING CONDITION

Table 3. Resource indicators and measures for the existing condition

Resource Element	Resource Indicator	Measure	Existing Condition
Soil Productivity	Detrimental Soil Conditions	Acres of detrimental soil conditions	3,930
	Droughty Soils	Acres of droughty soil types treated	0
Soil Erosion	Erosion Potential	Tons/acre of hillslope erosion modeled from WEPP	0
		Acres of soils with high erosion potential	20,144
		Miles of temporary roads on high erosion potential soil	0

Resource Element	Resource Indicator	Measure	Existing Condition
Slope Stability	Landslide Potential	Acres of slopes with increased landslide potential	1,685
		Miles of temporary roads on slopes with high landslide potential	0

Soil Productivity

In order to determine the existing condition of soils within the proposed activity areas, field investigations were conducted to determine if and how existing soil condition was affected by past management activities or other dispersed activities (e.g., off-highway vehicle travel and firewood cutting). In addition, areas within proposed activity areas that would require Project Design Criteria (PDC) to address conditions, such as sensitive soils that are wet, steep, or had evidence of past harvest that caused compaction, displacement, rutting, puddling, or soil erosion, were identified.

Most soils on the Wallowa-Whitman NF, including those within the project area, have a surface that formed in or is strongly influenced by volcanic ash loess and, thus, are similarly classified. Since most soil quality monitoring on the Wallowa-Whitman NF has occurred on soils that have a volcanic ash-influenced surface, there are a large number of both quantitative and qualitative ratings that relate to the soils in the project area. This information has two valuable implications:

1. We can estimate the amount of detrimental soil disturbance that exists from past management activities by doing transects and observing the amount of visible detrimental disturbance present and
2. We can estimate the amount of detrimental soil disturbance to expect from proposed management activities on given soil types and thus estimate the effects on the soil resource.

Detrimental Soil Conditions

Several vegetation management projects have been completed in portions of the project area over past decades. Multiple entries over many decades for timber harvest and other purposes have occurred, and residual soil disturbance is widespread in extent. Based on field visits and monitoring units, many of the soils are recovering with the assumption that they were impacted at various levels during previous entries. Past harvest prescriptions include commercial thin, group selection cut, improvement cut, overstory removal, patch clearcuts with and without leave trees, pre-commercial thin, salvage cut, seed-tree seed cut, single-tree selection, mechanical site preparation, hazardous fuel thinning, yarding of fuels, and past harvests without project records. Before the current forest plan, skid trails were often not pre-designated, and as a result, were randomly distributed throughout the old units. Skid trails were spaced approximately 50 to 100 feet apart. Table 4 below, summarized DSC results for activity areas proposed in this project. Existing condition DSC calculations include known system and non-system roads, as directed by Region 6 Soil Quality Standards.

Table 4. Existing Detrimental Soil Conditions

Unit	Acres	Existing Condition DSC (%)	Unit	Acres	Existing Condition DSC (%)	Unit	Acres	Existing Condition DSC (%)
300	151	3%	302	18	6%	304	12	5%
301	91	3%	303	8	10%	305	31	4%

Unit	Acres	Existing Condition DSC (%)
306	7	3%
307	16	5%
308	12	8%
309	3	3%
310	30	3%
311	9	4%
312	22	3%
313	22	3%
315	26	11%
316	43	4%
318	36	3%
319	52	3%
322	33	3%
323	24	7%
324	52	3%
325	26	4%
326	48	5%
327	118	3%
328	57	3%
329	31	3%
331	19	3%
332	24	3%
333	14	6%
334	7	6%
335	23	9%
336	100	3%
337	30	11%
338	32	4%
340	6	3%
341	4	5%
342	42	10%
343	16	3%
344	8	3%
345	139	3%
346	92	3%
347	33	3%
348	6	4%
349	4	4%
351	19	3%
352	24	3%
354	113	3%

Unit	Acres	Existing Condition DSC (%)
355	6	3%
356	32	3%
357	50	3%
358	13	3%
359	19	4%
360	96	3%
361	34	4%
363	4	3%
364	31	3%
365	43	3%
366	21	3%
367	33	3%
369	41	3%
370	37	3%
371	85	9%
372	16	6%
373	22	10%
374	3	5%
375	17	4%
376	6	3%
377	45	3%
378	50	3%
379	59	3%
380	77	15%
381	41	7%
382	185	4%
383	104	14%
384	21	11%
385	23	3%
387	29	4%
391	18	3%
392	72	3%
393	35	10%
394	11	11%
395	39	10%
397	9	4%
399	7	12%
400	42	10%
401	29	4%
402	30	4%
403	49	7%

Unit	Acres	Existing Condition DSC (%)
404	12	3%
405	113	6%
406	3	3%
407	6	3%
408	28	3%
409	61	9%
410	41	3%
411	63	9%
412	7	3%
413	14	4%
414	41	9%
415	26	12%
416	8	4%
418	12	3%
419	81	10%
421	48	10%
422	19	7%
423	29	5%
425	7	3%
426	21	4%
427	42	11%
428	9	6%
429	5	4%
431	23	3%
432	36	12%
433	14	5%
434	49	12%
435	63	7%
436	6	3%
437	91	8%
438	125	7%
440	13	3%
442	120	3%
443	21	3%
444	15	7%
445	10	11%
446	23	4%
447	8	3%
450	2	7%
451	16	4%
452	11	4%

Unit	Acres	Existing Condition DSC (%)
453	21	3%
454	35	3%
456	13	3%
457	7	3%
458	115	3%
460	39	3%
463	11	3%
464	44	3%
465	20	13%
466	58	10%
468	14	4%
469	6	4%
471	27	4%
472	22	3%
473	15	3%
474	84	5%
476	9	4%
477	55	4%
478	37	4%
482	79	6%
483	22	3%
484	24	3%
485	23	3%
489	36	4%
491	189	12%
492	136	12%
493	30	6%
494	6	11%
495	8	4%
496	8	8%
498	30	15%
499	24	3%
501	14	3%
502	14	15%
505	12	15%
507	504	13%
508	385	13%
510	436	13%
511	36	13%
512	71	10%
513	308	8%

Unit	Acres	Existing Condition DSC (%)
519	356	14%
520	55	15%
521	31	15%
523	11	13%
524	7	4%
525	100	3%
526	13	5%
531	13	8%
532	31	4%
533	6	9%
534	8	13%
536	423	12%
537	43	13%
538	91	8%
539	22	3%
541	72	8%
542	191	10%
544	37	15%
545	20	15%
546	277	15%
548	234	15%
550	122	15%
554	431	5%
555	29	5%
556	32	3%
557	92	7%
558	321	5%
559	42	3%
560	122	14%
561	282	15%
563	8	3%
569	144	15%
571	5	3%
572	31	4%
575	418	6%
576	41	4%
578	41	3%
579	8	3%
582	12	3%
583	9	15%
584	4	4%

Unit	Acres	Existing Condition DSC (%)
585	13	11%
586	10	11%
587	3	11%
700	163	10%
701	234	10%
702	686	7%
703	152	12%
704	66	6%
705	3190	5%
706	122	13%
707	186	5%
708	7	12%
709	3	13%
710	34	13%
711	686	9%
712	9	7%
713	211	12%
715	3	3%
716	33	3%
719	185	8%
720	325	11%
721	183	4%
722	34	3%
723	62	3%
724	156	5%
725	49	12%
726	657	6%
727	1080	5%
900	13	15%
902	3	3%
904	13	15%
905	58	15%
906	88	6%
907	8	15%
909	230	5%
910	9	15%
911	93	8%
912	13	14%
914	7	15%
917	23	14%
919	114	12%

Unit	Acres	Existing Condition DSC (%)
920	22	15%
923	567	4%
924	33	11%
925	4	3%
927	19	9%
929	5	3%
930	24	16%
931	54	13%
932	19	11%
933	393	6%
935	3	3%
937	2	11%
938	6	11%
939	96	13%
941	249	15%
942	13	15%
943	4	11%
944	22	12%
946	20	3%
947	267	3%
948	78	3%
949	0	3%
950	26	3%
951	53	3%
952	12	3%
953	54	3%
954	1	3%
955	79	3%
957	21	9%
958	1	3%
959	74	7%
960	38	15%
961	74	13%
962	22	3%
963	55	6%
964	5	3%
965	412	3%
968	11	5%
969	177	12%
970	5	9%
971	20	14%

Unit	Acres	Existing Condition DSC (%)
972	4	4%
975	16	3%
977	6	3%
978	79	10%
979	2	9%
980	47	14%
982	14	15%
983	50	3%
985	6	13%
989	67	3%
990	36	15%
991	6	11%
993	1296	10%
994	270	9%
995	31	8%
997	116	9%
1000	21	15%
1001	104	9%
1002	9	3%
1004	9	15%
1005	91	12%
1007	35	3%
1008	253	9%
1009	11	3%
1010	16	3%
1011	86	14%
1012	30	8%
1013	12	3%
1014	13	4%
1015	19	4%
1016	58	9%
1017	139	10%
1018	273	10%
1019	94	8%
1020	22	10%
1021	8	15%
1024	153	6%
1025	112	13%
1026	8	4%
1027	14	14%
1029	20	5%

Unit	Acres	Existing Condition DSC (%)
1030	28	14%
1032	64	6%
1033	2	3%
1035	9	3%
1036	2	3%
1037	62	3%
1038	25	3%
1040	138	13%
1044	6	9%
1045	38	11%
1047	60	4%
1050	5	3%
1053	21	15%
1054	24	9%
1055	2	3%
1057	4	3%
1058	8	3%
1059	101	11%
1061	25	11%
1063	39	14%
1067	18	4%
1068	673	3%
1069	1	3%
1070	29	3%
1071	11	14%
1072	7	3%
1074	55	5%
1075	3	3%
1076	6	11%
1078	45	3%
1079	10	16%
1080	82	10%
1081	7	3%
1083	78	8%
1086	23	5%
1087	102	8%
1088	5	15%
1089	13	15%
1091	13	3%
1092	13	15%
1093	10	8%

Unit	Acres	Existing Condition DSC (%)
1094	6	15%
1095	14	4%
1097	8	14%
1098	70	13%
1099	9	11%
1102	94	3%
1103	11	3%
1104	15	4%
1105	26	4%
1106	32	3%
1107	5	3%
1108	13	11%
1109	27	6%
1110	3	4%
1111	101	4%
1112	6	4%
1113	163	6%
1114	4	12%
1116	53	13%
1117	4	11%
1118	13	4%
1119	81	7%
1121	40	9%
1122	37	3%
1123	1	3%
1124	2	7%
1126	143	4%
1128	2	3%
1130	4	3%
1131	31	7%
1132	71	6%
1133	1	11%
1134	214	11%
1136	154	15%
1139	108	15%
1142	8	15%
1143	5	5%
1144	36	13%
1145	25	9%
1146	2	15%
1147	99	13%

Unit	Acres	Existing Condition DSC (%)
1148	18	12%
1149	7	15%
1150	32	15%
1151	7	15%
1152	175	15%
1153	7	15%
1154	62	16%
1155	7	15%
1156	28	10%
1157	2	4%
1158	53	12%
1160	173	15%
1161	141	12%
1163	55	8%
1164	16	5%
1166	15	15%
1167	1	3%
1170	10	15%
1171	13	15%
1172	23	9%
1173	127	16%
1174	495	13%
1175	38	15%
1176	238	3%
1178	12	5%
1179	38	11%
1180	72	3%
1181	23	3%
1182	1	3%
1183	13	14%
1184	30	8%
1185	482	12%
1186	316	8%
1187	22	6%
1188	17	3%
1189	69	4%
1190	267	3%
1191	9	3%
1192	189	3%
1193	22	7%
1197	0	3%

Unit	Acres	Existing Condition DSC (%)
1198	66	8%
1200	12	16%
1201	1	15%
1202	44	3%
1203	232	7%
1204	15	5%
1205	4	13%
1206	21	13%
1207	13	13%
1208	15	13%
1209	25	13%
330A	14	3%
330B	7	7%
339A	37	4%
339B	20	3%
350A	23	4%
350B	6	3%
350C	3	3%
353A	3	3%
353B	8	3%
362A	16	4%
362B	54	4%
368A	6	4%
368B	44	3%
385A	17	4%
385B	178	8%
386A	21	3%
386B	16	3%
388A	64	3%
388B	6	3%
388C	158	3%
389A	34	4%
389B	8	3%
389C	65	3%
390A	15	3%
390B	6	3%
396A	56	7%
396B	7	3%
398A	35	3%
398B	9	4%
420A	2	11%

Unit	Acres	Existing Condition DSC (%)
420B	34	13%
420C	59	13%
424A	4	3%
424B	8	3%
430A	2	4%
430B	5	4%
430C	4	3%
430D	1	11%
439A	11	3%
439B	4	3%
441A	11	3%
441B	30	3%
448A	5	4%
448B	184	3%
454A	8	3%
459A	28	3%
459B	23	3%
459C	8	3%
459D	6	3%
461A	78	3%
461B	140	8%
461C	3	3%
462A	39	3%
462B	146	5%
467A	68	13%
467B	36	4%
470A	16	3%
470B	30	6%
475A	8	4%
475B	13	3%
479A	40	6%
479B	2	15%
480A	37	3%
480B	9	4%
481A	7	4%
481B	15	13%
481C	81	5%
486A	9	3%
486B	161	11%
487A	18	14%
487B	25	8%

Unit	Acres	Existing Condition DSC (%)
488A	39	5%
488B	12	4%
490A	6	15%
490B	27	10%
497A	214	9%
497B	22	3%
497C	56	8%
500A	6	4%
500B	27	3%
503A	39	13%
503B	293	13%
503C	123	15%
504A	240	12%
504B	566	15%
504C	206	15%
504D	40	3%
506A	40	11%
506B	362	8%
506C	135	13%
509A	51	12%
509B	265	4%
514A	73	3%
514B	180	8%
515A	54	14%
515B	105	3%
516A	77	15%
516B	63	11%
517A	138	12%
517B	86	8%
518A	9	15%
518B	10	15%
522A	5	15%
522B	10	15%
522C	13	15%
522D	6	15%
522E	78	11%
527A	6	4%
527B	6	4%
527C	13	3%
527D	8	3%
528A	5	3%

Unit	Acres	Existing Condition DSC (%)
528B	262	12%
529A	72	6%
529B	12	8%
529C	29	13%
530A	22	12%
530B	85	6%
535A	7	13%
535B	192	12%
540A	88	8%
540B	44	11%
543A	528	7%
543B	27	15%
547A	54	15%
547B	106	15%
547C	104	15%
547D	16	15%
549A	10	15%
549B	22	15%
551A	7	15%
551B	11	15%
551C	147	15%
551D	425	15%
552A	566	14%
552B	13	3%
554A	12	5%
558A	9	15%
562A	22	15%
562B	79	10%
562C	26	3%
564A	145	15%
564B	78	15%
564C	1026	14%
565A	76	4%
565B	6	3%
566A	19	3%
566B	120	3%
567A	46	3%
567B	80	3%
568A	67	15%
568B	19	10%
570A	31	4%

Unit	Acres	Existing Condition DSC (%)
570B	24	10%
573A	32	5%
573B	99	4%
574A	156	4%
574B	73	4%
574C	59	7%

Unit	Acres	Existing Condition DSC (%)
574D	14	8%
574E	58	5%
577A	14	6%
577B	8	3%
580A	64	5%
580B	76	6%

Unit	Acres	Existing Condition DSC (%)
581A	17	4%
581B	11	3%
581C	31	9%

Soil Productivity Trends

Soil quality in the project area is stable to trending upward. Most disturbed soils have lots of roots throughout the upper soil layers. Evidence of old compaction, evidence in soils with platy structure, have begun to recover from established root systems of vegetation and rodent burrows. Field observations revealed that on average, within units visited, 32% of units had exposed mineral soil. Many legacy trails had an adequate amount of effective ground cover, while some trails and landings had exposed mineral soil due to soil bulk density being too high for root penetration. In most cases, skid trails and landings represent the greatest amount of legacy disturbance in the project area. Literature indicates that disturbed soils improve by means of plant growth, bioturbation, freeze/thaw cycles, wet/dry cycles, and organic matter additions, all of which naturally occur in the project area (Elliot et al., 1999). These natural processes effectively improve compacted soils over time (Lull, 1959). Compaction recovery rates are highly variable with an expected range of 10 to 70 years (Gonsior, 1983). The target downed wood for dry ponderosa pine sites is 5 to 10 tons/acre and 7 to 15 tons/acre for mixed conifer sites for moderating soil productivity while minimizing fuel hazard (Brown et al., 2003; Graham et al., 1994). Monitoring of 30 units within the project, revealed that 30% of units visited had adequate downed wood for soil productivity, while 63% had less than adequate downed wood, and 7% had an excessive amount of down wood for the site. The average downed wood across units visited was 5.0 tons/acre. The average optimum level of fine organic matter is 21 to 30 percent (Graham et al., 1994), this equates to 2.5 to 5 cm of surface litter and humus, which provides a good indicator of healthy forest soil (Jain and Graham, 2009). Forest floor litter and duff depths were measured across survey units. Total organics in units ranged from 0.0 to 5.0 cm, with an average of 1.6 cm.

Droughty Soils

Due to fire suppression, many areas on the Wallowa-Whitman have become unsustainably overstocked. During low precipitation periods, when soil does not have the ability to supply moisture to support those overstocked conditions, drought stress occurs and forest health risks (e.g., insect and disease) increase. Some stands are currently managed at densities that may be unsustainable under projected climate variations and are considered to have reduced soil productivity (i.e., reduced ability to supply water and nutrients needed to sustain plant growth). Thinning of overstocked vegetation, with a focus on maintaining vegetation densities within the capacity of the soil to support productive growth, should be included in forested landscape management objectives. Restoration of soil moisture and plant community ecological processes is also an important aspect of adapting to climate change and creating resilient landscapes. There is currently 22,745 acres of forested stands on droughty soil types within the project area.

Sensitive Soils

Dry meadows with shallow soils are considered sensitive soil types because of their shallow soil depth and inability to recover from disturbance events. There are dry meadows with shallow soils scattered throughout the project area. These areas are defined as having thin, rocky soils with drought tolerant plants (Johnson and Simon, 1987). These soils have more rock and clay than soils influenced by loess or volcanic ash. When located on concave surfaces, these soils are often saturated until mid to late July. Disturbance tends to disrupt the rock-moss-plant species. Care must be taken to avoid these areas when choosing landing sites and skid trail locations. The Wallowa-Whitman 1990 LRMP Standards and Guidelines specifically identify these soils and require avoidance and mitigation measures to provide protection. There are 2,203 acres of shallow soils within the project area.



Clay-dominated soils are also considered a sensitive soil. Clay soils tend to hold onto moisture because of small pore sizes and are not appropriate for road use. Operating on clay soils during wet conditions can result in severe compaction and/or puddling and should be avoided until they are completely dry. There are 538 acres of clay-dominated soils within the project area.

Thick ash cap soils are also considered a sensitive soil. Volcanic ash has a low bulk density and bearing strength, which enables a high-water holding capacity (Geist and Strickler, 1978; Geist et al., 1989). The low bulk density also increases the potential for rutting and compaction. In these areas, ground based equipment would be carefully managed to prevent ash cap loss and confined to period when soil is dry, frozen, or snow covered. There are 11,172 acres of thick ash cap soils within the project area. Vegetation will recover quickly reducing erosion, and in the case of pinegrass plant associations, the pinegrass mat helps hold the soil in place.



Sensitive soils contain an excess of soil moisture either yearlong or on a seasonal basis and have an udic soil moisture regime. Disturbance on these sensitive soils can lead to loss of productivity. Soils with udic soil moisture regimes require PDCs for protection and mitigation (Soil PDC 5). There are 8,689 acres of udic soils within the project area.

Hydric soils are wetland soils also considered sensitive, they are defined as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA NRCS, 2018). Hydric soils facilitate and regulate the flow of water between groundwater systems and surface water systems. Biogeochemical cycling is dependent on the combination of aerobic and anaerobic conditions in hydric soils. The capacity of hydric soils to retain water and develop anaerobiosis promotes specific plant communities and unique wildlife habitats. Wetlands are defined in regulations, 16 U.S.C. Section 3801(a)(27) :“as land that has – 1.Has a predominance of hydric soils, 2. Is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, 3. Under normal circumstances supports a prevalence of such vegetation. For the purposes of FSA [Food Security Act] and any other Act, this term does not include lands in Alaska as identified as having high potential for agricultural development that have a predominance of permafrost soils”. These soils will be treated as a wetland according to INFISH and Forest Plan definitions, which will prevent resource damage (See Aquatics Report for more information on RHCAs). There are 1,129 acres of hydric soils within the project area.



Low productivity soils have inherent soil properties that lower the soils ability to retain adequate organic matter reservoirs needed for nutrient cycling and maintenance of long-term site productivity. There are 1,300 acres of low productivity soils in the project area.

Soil Erosion

Soil erosion is a natural process that can be accelerated by land management activities; it depends on soil texture, rock content, vegetative cover and slope. Erosion hazards can be ameliorated by operating on slopes less than 30 percent with good vegetative cover. Vegetation binds soil particles together with roots and vegetative cover and protects the soil surface from raindrop impact and dissipates the energy of overland flow. The dominant erosion risk for undisturbed soils in this project are low to moderate. A majority of the project area is characterized by gentle slopes and soils with high infiltration rates. The high rock fragment content of most subsurface horizons also promotes water movement through the soils. Runoff from these soils is uncommon.

Existing annual soil loss for hillslopes within this project were modeled to determine baseline upland erosion rates. The WEPP model results estimated the mean average annual soil loss for all watersheds modeled, to be 0.0 tons per acre (Table 7). Geiser Creek was the only drainage modeled that showed elevated baseline soil loss, however this soil loss was seen only in the 30-year return period. The Geiser Creek 30-year return period analysis estimates a 3% probability of 0.74 tons of erosion being produced at a rate of 0.0 tons per acre.

Slope Stability

Table 5 lists acres of slope instability within all activity areas. The dominant landslide potential rating for this project is low. There are 1,519 acres within the project area that have increased potential for landslides. There are 319 acres within the project area that are existing landslide areas, 152 of these acres overlap with increased potential landslide data. The total acres of increased potential and existing landslide area is 1,685 acres.

Table 5. Landslide potential in the project area

Landslide Potential	Acres
Low	41,011

Landslide Potential	Acres
Low to Moderate	5,931
Moderate	329
Moderate to High	1,519
Existing	319

ENVIRONMENTAL CONSEQUENCES

ALTERNATIVE 1 - NO ACTION

Soil Productivity

The No Action alternative would not cause short-term effects on the soil resource over and above existing condition. No additional road building, timber harvest, prescribed burning, or fuel reduction would disrupt natural soil processes.

Physical Soil Characteristics

The No Action alternative would not cause soil compaction, rutting, puddling, or soil displacement. Undisturbed soils would remain so. Soil productivity in areas where past timber management compacted soils would slowly improve as plant roots, soil organisms, and freeze-thaw events loosen the soil. Most soil disturbances would recover after 70 years (Gonsior, 1983). Sites that are slightly compacted would recover in fewer than 70 years. Displaced, rutted, and puddled soils would have reduced productivity for a longer time than compacted soils.

Organic Matter

Standing dead trees would eventually fall over and contribute coarse woody debris and additional organic material would be recruited through natural mortality. Fine-woody debris would remain on site. Soil organisms would decompose the organic materials adding humus to the soil. Nutrients associated with this material would slowly become available for plant growth. As the tree canopies close and shade the soil surface, decomposition rates would slow, allowing organic matter and nutrients to accumulate on the soil surface. This process would continue until another major disturbance, such as fire or a windstorm, opens the tree canopy and speeds up the recycling process again.

Soil Biological Activity

Microorganism populations would fluctuate with the changes in microclimate and supply of organic matter on the soil surface. These changes would be in response to the changing vegetation as a result of natural events such as fire, wind throw, and other sources of natural vegetation mortality. Any changes would be buffered by the capability of the soil microbial communities to adapt to changing conditions on very short time scales (Schmidt et al., 2007).

Soil Erosion

No action would allow any current soil erosion to decrease as vegetation returns to soils that lack plant cover. Wildfires could cause short-term increase in soil erosion. Soil erosion rates would fluctuate with natural changes in vegetation and associated ground cover.

Soil Stability

No action would not change the risk of mass failures within the project area. Most slopes are considered currently stable. Mass failures are unlikely with no management actions.

ALTERNATIVE 2 AND 3

Project Design Features and Mitigation Measures

1. In areas where **more than 20 percent** detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration must, at a minimum, not exceed the conditions prior to the planned activity and should move towards a net improvement in soil quality (R6 Soil Quality Standards).
2. In areas where **less than 20 percent** detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 20 percent. In units expected to exceed 20 percent detrimental soil conditions:
 - Rehabilitate landings and used skid trails as needed thru de-compacting to bring post-activity DSCs to acceptable levels in each activity area.
 - If de-compacting is not feasible (i.e., shallow, clayey, rocky and/or topographic constraints) restrict harvest activities to winter harvest conditions.
 - If none of the above actions are feasible, then the particular treatment area should be excluded from mechanical activities.
3. Limit equipment operations to frozen, snow-covered or acceptable soil moisture conditions (as described in Appendix B). Limit machine pivots and turns, where possible.
 - During the winter season ground conditions shall meet at least one of the following criteria for machine operations:
 - Six inches of frozen ground,
 - Four inches of frozen ground with one foot of snow,
 - Two feet (>24 inches) or more of snow,
 - One foot (>12 inches) slash mat in combination with one foot of snow, or
 - Soil moisture conditions acceptable for minimizing rutting or puddling of soils
 - Some “watch-out” situations include:
 - Machine break-through begins to occur
 - Equipment tracks sink deeply (half the width of the track) below the soil surface with one or two passes
 - Ruts greater than six inches deep form
 - Mid-day temperatures are forecast to rise above freezing
 - Surface melt occurs over still-frozen subsurface
4. Avoid operating on shallow soils (<25 cm soil depth) and meadows unless over frozen ground/snow. Shallow soils and clayey soils should not be used for temporary roads, skid trails, slash piles, or log landings; unless no other location is practical and there is an existing

prism in which case equipment activity should remain within existing prism as much as possible.

5. Avoid early summer equipment operations on units with udic moisture regime (moist soils with inherent excess soil moisture either yearlong or on a seasonal basis). If this is not possible or there is evidence of lingering moisture present, operate on a bed of slash maintained at >12 inches to mitigate compaction and rutting.
6. Ground-based equipment should not operate on sustained slopes exceeding 30%, unless reviewed by soil specialist or hydrologist. Prioritize areas of slopes greater than 30% as leave areas within units.

Designated skid trails should be spaced on average 100 feet apart, and the trails should average no more than 12 feet in width. Closer spacing due to complex terrain will be with Timber Sale administrator approval. Existing skid trails will be used as much as possible.

- If equipment must leave designated trails for operational purposes, no more than two passes over any piece of ground is permitted.
- Ensure that water control structures (water bars or slash surfacing, as approved by the Sale Administrator or COR) are installed and maintained on skid trails that have gradients of 10 percent or more; Ensure erosion control structures are stabilized and working effectively before spring runoff.

When cut to length harvest systems are used, maintain an appropriate slash mat of at least 12" when possible during operations to prevent equipment weight from altering soil bulk density and causing displacement of effective ground cover. If unable to maintain an appropriate slash mat, impacts are expected to be the same as tractor logging

7. Whole-tree yarding methods should be avoided in shallow soils (<25cm), nutrient-poor (granitic soil, glacial outwash sands, many coarse-textured soils) soils or in sensitive ecosystems. If not possible, backhaul slash and redistribute on skid trails to an average depth of 6 inches within the harvest area, and extend the time period for reentry to allow more time for nutrient inputs.
8. Use advanced logging systems where treatment is planned for continuous slopes greater than 30%. Advanced logging systems may include a variety of techniques including, but not limited to, cable yarding or other advanced logging systems where adequate protection against soil compaction and displacement can be demonstrated.
 - Use directional hand falling of trees and winching on slopes greater than 30% that cannot be reached by harvesting equipment from designated skid trails, as much as possible. Leading end suspension should be implemented when cabling or skidding material.
 - Skid trails or yarding corridors on slopes greater than 30% used by the purchaser should be reclaimed by applying appropriate erosion control measures such as the placement of effective ground cover in conjunction with, or in place of, water bars for rehabilitation.
9. Commercial RVR treatments will utilize cut to length harvest systems and will leave slash generated if the quantity is not in conflict with fuel objectives. NCT and PCT RVR treatments will utilize tracked grapple equipment, and evenly distribution small slash piles. Erosion control measures will be installed after all ground-disturbing activities.
 - Slash should provide at least 65% effective ground cover and up to 8 tons of slash per acre. Slash piles should be burned when soil moisture is high, and piles are small (less than 25 square feet).

10. Signs of slope instability and mass movement include cracks in soil, tilted or bent trees, increased spring activity or newly wet ground, hummocky or uneven terrain, sunken or broken roadbeds, and/or a recent sag pond has formed that isn't human created. Specific design criteria for unstable or potentially unstable areas provided by geotechnical engineers are as follows:
- 1040 road historic landslide - No road construction will occur within the Headscarp during the wet season or near any wet areas with slopes greater than 30 degrees. The area will be monitored the first two years or as needed following prolonged saturated periods within 5 years of timber harvest and if it appears that landslide movement is occurring (slumping, change in slope, etc), then a field inspection will be done by a professional engineer.
 - Other landslide areas on RD 1042-105 and RD 1046-35 will require periodic maintenance of ditches due to sloughing along road cuts.
 - Other landslide areas on RD 7380, RD 1046-160, and RD 1055-300 will require a TSIL – D assessment before implementation of proposed activities. There will be no new road construction during wet season or when the ground is saturated. Additionally:
 - The landslide area on the 7380 road will require field inspection by a professional engineer prior to **any** new road construction.
 - The landslide area on the 1046-160 road will require field verification by a professional engineer prior to implementation of proposed activities.
 - The landslide area on the 1055-300 road, will require field investigation by a professional engineer, prior to implementation of proposed activities.
11. Retain adequate supplies of coarse woody debris (CWD) (greater than three inches in diameter) to provide organic matter reservoirs for nutrient cycling and microbiotic (fungi and bacteria) habitat following completion of all project activities. Dry forest stands should have 5 to 10 tons per acre of coarse woody debris retained within the stand. Moist – mixed conifer stands should have 7 to 15 tons per acre of coarse woody debris retained within the stand.
- In order to retain adequate organic matter reservoirs for nutrient cycling and maintenance of long-term site productivity, minimize disturbance and piling of decaying large woody debris during fuel treatments. Strive to maintain fine organic matter (commonly referred to as the duff layer) over at least 65 percent of an activity area following both harvest and post-harvest operations. Keep fine organic matter disturbance to a minimum if the potential natural plant community on site is not capable of producing fine organic matter over 65 percent of the area (Regional Soil Quality Guidelines / FSH 2090.11).
12. Prior to the seasons ending precipitation event, ensure necessary water control structures are installed and maintained on skid trails over 10% slope after all ground-disturbing activities. Ensure erosion control structures are stabilized and working effectively and ensure that effective ground cover is left.
- In areas of general disturbance in ash soils, the top layer (A Horizon) should be pulled back over any disturbed surface to prevent permanent loss of productivity. (Pull berms back over disturbed surfaces)
 - After completion of land management activities, the minimum effective ground cover (EGC) within each activity area within disturbed areas shall be in place to prevent erosion from exceeding background erosion rates for each of the four established erosion hazard classes: low, medium, high or very high (table below). Effective ground cover is defined as the basal area of

perennial vegetation, plus duff, litter and coarse fragments (greater than 2mm sizes), including tree crowns and shrubs that are in direct contact with the ground.

Erosion Hazard Class	Minimum Effective Ground Cover	
	1st Year	2nd Year
Low	20-30%	30-40%
Medium	30-45%	40-60%
High	45-60%	60-75%
Very High	60-90%	75-90%

13. In areas where de-compacting is prescribed, de-compact to a depth sufficient to ameliorate the presence of detrimental soil compaction (usually between 2 and 12 inches). Discontinue de-compacting where large rocks are continually brought to the soil surface. If a change in soil color is noticed by the operator, operate at a shallower depth that prevents topsoil and subsoil from mixing. Skid trails on slopes steeper than 30 percent should not be de-compacted.
 - Effective ground cover for all de-compacting treatments should take advantage of harvest slash. If no suitable organic material is available, then weed free straw or other equivalent erosion control measures should be applied on slopes exceeding 15%, adjacent to waterways and ditches (within 100 feet), prior to seasons ending precipitation event. See BMP AqEco-2 for additional information.
14. Non-system or legacy road templates will be used for temporary roads to the greatest extent possible. Creation of new temporary roads will be minimized and will be located to minimize or mitigate adverse effects to soil, water quality and riparian resources. Locate roads to fit the terrain and follow natural contours. Placement of new temporary roads should be on deep soils, as possible. Avoid creating new temporary roads on clay-dominated soils. Any new temporary roads within RHCA's will be approved by a hydrologist and sale administrator. Any temporary road development on slopes greater than 30% will require engineering and road support. Temporary road sediment mitigation strategy should include:
 - Locate on benches where possible to reduce cut/fill construction and sedimentation risks
 - Provide adequate drainage
 - Adopt stormproof designs by outsloping, water drainage features, and location
 - Have a post-harvest rehabilitation plan for temporary roads that include culvert removal, outsloped template, scarification or de-compacting, placement of slash materials, and seeding as appropriate

Rehabilitate all temporary roads used for the current entry (existing and new). This may include masking/obliterating entrances, de-compacting, culvert removal, re-contouring cuts and fills, hydrologically stabilizing, seeding, and/or placing fine slash or other organic materials over treated surfaces to establish effective ground cover protection where available. Install suitable storm water and erosion control measures to stabilize disturbed areas and waterways before seasonal shutdown of project operations or when severe or successive storms are expected.

Slash and organic material that has to be incorporated into road rehabilitation should not be burned. De-compacting of temporary roads may occur as a post-sale area improvement activity where conditions are appropriate.

Rehabilitation of non-system roads used for project activities, will be proposed for KV funding for improvement of hydraulic function, watershed conditions, and soil productivity.

Realignment can cause considerable disturbance to an area and short-term increased soil erosion. Techniques to help reduce negative effects to riparian areas are soil bioengineering, landslide

mitigation strategies, and erosion control devices. Soil bioengineering techniques include live staking, live crib walls, live fascines, brush layering, branch packing, gully repair, and log terracing. Erosion control devices include barriers, retention structures, and mulches. The most common temporary barriers are filter fences, straw bales, and straw wattles. The most common retention structure is the sediment basin, often used to mitigate disturbances during construction, and sited below known sources of sediment. Mulches include straw, woodchips, and soil adhesives to protect bare soil or recently seeded areas.

15. Grapple pile operations would use the same skid trails as harvest operations where possible. Mechanical fuel operations would adhere to ground-based equipment PDCs mentioned above.

Where feasible, pile slash on sites already disturbed by logging activities (e.g. skid trails, landings, and roads) in order to minimize additional detrimental soil impacts from burning. Avoid locating slash piles on shallow soils (<25cm). Piling slash should not occur above or below culverts or drainages to prevent sediment delivery. If piling fuels near a culvert or drainage, pile fuels away from the culvert or drainage high water flow. Limit hand pile size to less than 50 square feet to reduce organic horizon loss and limit soil heating. Pile burning when duff is moist or wet can reduce organic matter loss and soil heating.

When using a boom-mounted implement, operator shall plan off-trail travel paths to make full use of the machine's capability (e.g., using the full boom reach of the machine) to limit ground disturbance and minimize the number of off-trail passes.

Reclaim all machine-built fire lines by redistributing displaced topsoil and unburned woody debris over the disturbed surface as needed after burn has been completed. Install water bars on fire lines using the following guideline: 5-15% slope every 150 feet, 16-35% slope every 40 feet, 36-60% slope every 30 feet, and >60% slope every 15 feet. On slopes less than 15%, water bars may not be needed if adequate amounts of slash are available.

Avoid direct lighting of stumps and large woody debris greater than 9 inches in diameter during prescribed burn operations. Slash and organic material that has to be incorporated into road rehabilitation should not be intentionally burned.

16. Adequate amounts of slash should be left within the unit in order to retain fine organic matter on low productivity soils with inherently lower ability to retain adequate organic matter reservoirs. If Regional Soil Quality Standards and Guidelines are unable to be met because the stand is incapable of producing enough slash, all slash should be left untreated.

Direct and Indirect Effects - Alternative 2 and 3

Soil Productivity

Physical Soil Characteristics

Non-Commercial and Post-Commercial Thinning

Non-commercial and post-commercial thinning treatments will be used in the following thinning prescriptions: NCT, PCT, Defensible Fuel Profile Zone, Riparian Vegetation Restoration (RVR), Old Forest Preservation Stands (MA15), and Aspen Restoration. Under Alternative 2, approximately 14,666 acres are proposed for NCT treatments, and approximately 19,969 acres are proposed for PCT treatments. Under Alternative 3, there is no RVR treatments and approximately 10,921 acres are proposed for NCT treatments and approximately 19,502 acres are proposed for PCT treatments.

Both treatments will involve hand thinning and/or piling. These treatments frequently produce slash accumulations that are piled and burned to meet desired conditions. Hand thinning and piling would not generate detrimental soil conditions, but the associated grapple piling and pile-burning could. Hand pile-burning could result in minor changes to soil structure where temperatures between 220 and 460 C are

generated (DeBano et al., 1998; Busse, 2014). Burning slash piles when soil and duff moisture is high, reduces soil temperatures (Frandsen and Ryan, 1986) (Soil PDC 15). No significant effects to soil bulk density, infiltration capacity, or soil moisture content are expected from hand pile-burning (Seymour et al., 2004).

Grapple piling is proposed for both treatments where slopes are less than 30%. Grapple piling and subsequent pile-burning generates approximately 3% DSC (Bliss, 2004; Hanson, 2005). Use of ground-based equipment to grapple pile would have direct and indirect effects on soil physical characteristics within the boundaries of proposed activity areas. However, project PDCs to limit equipment operations to dry, frozen or snow-covered ground conditions would greatly reduce these potential effects. Soil compaction is reduced when soils are dry (below field capacity, i.e. below optimum water content) (McNabb et al., 2001; Starsev et al., 2001). Rutting and puddling are most often associated with ground-based mechanical equipment operation on wet soils (Williamson et al., 2000). Tracked equipment is generally used for grapple piling which minimizes changes to physical soil properties and reduces the aerial extent of impacts (Moghaddas and Stephens, 2008). The same mitigation and operational guidelines are required for grapple piling to reduce the potential for soil productivity losses. Slope limitations and soil moisture guidelines would be applied to minimize DSC caused by equipment movement. The same designated trail systems would be used in post-commercial thinning treatments as were used in the commercial harvest, which would reduce the extent of disturbance.

Commercial Thinning

Commercial thinning treatments will be used in the following thinning prescriptions: Thin from Below, Group Selection, Post and Pole Harvest, Defensible Fuel Profile Zone, Riparian Vegetation Restoration (RVR), Old Forest Treatment, and Aspen Restoration. Commercial thinning treatments proposed will utilize both ground-based and cable yarding systems. Approximately 23,470 acres are proposed for commercial harvest under Alternative 2. Under Alternative 3, there are no RVR treatments proposed, and approximately 22,989 acres are proposed for commercial harvest.

Commercial thinning operations would result in direct and indirect effects on soil physical characteristics within the boundaries of Alternative 2 and 3 activity areas (Table 6). Most detrimental effects would be concentrated on the proposed skid trails, temporary roads, and landings within or associated with ground-based activity areas. Minimizing the area occupied by landings and skid trails to reduce the detrimental effects on soil productivity from changes in physical soil properties is recommended in several papers (Garland, 1983; Page-Dumroese, 2006; Williamson et al., 2000; Amaranthus 1996). Ground disturbing activities would be laid out to occupy less than 20 percent of each activity unit including system roads. System roads in this project area average 1.7 percent of the analysis area. Landings occur approximately every 10 acres of an activity area and occupy a space of approximately ¼ acre. Acres of skid trails are assumed to be 1/10th of the unit and only half are considered to produce new DSCs. The other half are assumed to be on old skid trails. New skid trail DSCs are calculated by taking half of the estimated skid acres and dividing that value by the unit acres. For tractor harvest, that number will always be 5%. In addition to using designated skid trails and landings, there would be potential to reduce soil effects further by limiting equipment operation on skid trails to when soils are dry (below field capacity, i.e. below optimum water content) (McNabb, 2001; Startsev et al., 2001). Rutting and puddling are most often associated with logging on wet soils (Williamson et al., 2000). Most summer logging would occur when soils are drier than field capacity. By operating on low soil moisture conditions, we have the potential to reduce the amount of detrimental disturbance from ground-based operations (Soil PDC 3). Limiting machine pivots and turns, where possible reduces the amount of soil displacement and compaction that occurs (Soil PDC 3).

Post and Pole treatments involve treating smaller diameter stands, typically utilizing a cut-to-length harvest system. This ground-based harvest system utilizes a slash mat that is created when harvesting and processing trees from a designated equipment trail. The equipment is then able to ride on top of the slash mat reducing compaction, displacement, and rutting (Allen and Adams, 1997). Cut-to-length harvest systems can afford some flexibility to operators at the beginning and end of the operating season, since an adequate slash mat can prevent compaction, displacement, and rutting with increased soil moisture (highly variable depending on spring and fall weather). Minimal direct and indirect effects from this treatment would be expected only if the harvest is able to produce adequate slash loads to elevate the equipment above the soil, with at least 12" of green slash to prevent the equipment weight from altering soil bulk density and displacement of effective ground cover (Soil PDC 6). If those conditions aren't able to be met, direct and indirect impacts on physical soil characteristics are expected to be the same as other ground-based harvest systems.

Cable yarding operations would result in direct and indirect effects on soil physical characteristics within the boundaries of the proposed activity areas (Purser and Cundy, 1992). Effects would be less than those from ground-based operations. Skyline yarding disturbs 2 to 8% of the soil in a unit. Based on field monitoring data, skyline yarding creates 1% detrimental disturbance from soil displacement (McIver et al., 2000). Skyline landings are typically 100-1,000 square feet and create 1% detrimental disturbance. When skyline slash is piled and burned it creates 1% detrimental soil disturbance from burn effects (Bliss, 2004).

Riparian Vegetation Restoration

There are only riparian vegetation restoration (RVR) treatments in alternative 2. This treatment involves commercial harvest and NCT/PCT treatments within riparian habitat conservation areas (RHCAs). Acres of RVR treatments are included in previously mentioned commercial, NCT, and PCT treatment acres. Direct and indirect effects to physical soil characteristics may be less in RHCAs because of PDCs designed to reduce ground-disturbing impacts and by operating under suitable ground moisture conditions (Soil PDC 3 and 9).

Commercial treatments in all RHCAs include mitigations to utilize cut-to-length harvest systems for ground-based operations and would leave slash generated (Soil PDC 9). Direct and indirect effects of cut-to-length harvest systems are discussed in the above commercial treatment effects. NCT and PCT treatments will include mitigations to utilize tracked grapple equipment, and an even distribution of small slash piles throughout the activity area instead of fewer, larger grapple piles (Soil PDC 9). Machine piling will be permitted where ground-based commercial harvest is permitted. Hand piles can occur where machine piling is not used, in the remainder of the RHCA. Lighting of hand and machine piles or jackpot burning will be permitted in RHCAs if slash is placed into small piles less than 25 square feet (Soil PDC 9). Burning of these piles could result in minor changes to soil structure if temperatures between 220 and 460 C are generated (DeBano et al., 1998), as discussed above in NCT and PCT treatment effect. Burning slash piles when soil and duff moisture is high, reduces soil temperatures (Frandsen and Ryan, 1986) (Soil PDC 9).

Temporary Road Construction

In Alternative 2 and 3, there are up to 39 miles of temporary roads proposed in this project. Average clearing width is assumed to be 12 feet for temporary roads and create 1.5 acres of DSC per mile (Table 6). All temporary roads used (existing and new) for this project would be decommissioned, also referred to as hydrologically obliterated, by any site-appropriate combination of the following:

- Masking or obliterating entrances,

- Subsoiling,
- Removing any installed culverts or temporary bridges,
- Recontouring the entire template to natural ground contour,
- Where recontouring is unnecessary, scarifying with excavator teeth to a depth sufficient to ameliorate the presence of detrimental soil compaction (usually between 2 and 12 inches),
- Seeding with the native plant mix as specified by the project Botanist,
- Placing woody material on the template and planting native shrubs/trees to augment natural vegetation.

Recontouring activities would not ameliorate the long-term impacts to soil productivity immediately but would improve soil conditions compared to those of an existing or abandoned road. The establishment of vegetation and associated additions of organic matter would encourage recovery over time. Recontouring would provide a suitable seed bed for native forest vegetation while increasing soil hydraulic conductivity, organic matter, total carbon, and total nitrogen (Lloyd et al., 2013). These conditions with the addition of woody material as effective ground cover would likely accelerate the recovery of soil productivity (Soil PDC 12 and 14) (Luce, 1997).

Summary

Since the 1990 Forest Plan, the level of concern for maintaining soil productivity has greatly increased. This increase has been accompanied with implementation of management practices that protect the soil. These changes include the use of excavators instead of dozers for mechanical site preparation, use of designated skid trails, operating when soils are dry or when winter conditions would protect soil productivity, harvester-forwarder systems, and use of slash layers to reduce effects on skid trails. In addition, vegetation management projects are audited for compliance with BMPs and are monitored as specified in the NEPA decision, both of which contribute to better results.

Table 6 shows the expected new and total DSCs for proposed action alternatives in this project. The final DSCs were calculated by adding existing DSCs with the new DSCs expected to result from the proposed activities. Alternatives 2 and 3 have 52 units that are expected to exceed the standard threshold of 20 percent detrimental soil conditions. There are some units in both alternatives that are small in size and may exceed the minimum acceptable soil productivity conditions by less than one half of an acre, because of the limited acreage, these units are not included for rehabilitation activities based on calculations having a margin of error, and professional knowledge and experience. Soil rehabilitation activities would occur after ground-based activities are complete and the contractor would be required to decompact landings and used or old skid trails as needed to bring DSCs below 20% (Soil PDC 2). If decompacting is not feasible then equipment would only operate under winter harvest conditions (Soil PDC 2). If none of these actions are feasible, then the particular treatment area would be excluded from mechanical activities. All action alternatives will ensure that soil productivity will move toward a net improvement in soil quality. Additional protection of the soil resource would be afforded by having ground-based operations only when soils are dry, snow covered, or frozen. Grapple piling and burning generates minimal DSC and is prescribed in NCT and PCT treatments. Hand treatments would not be expected to result in any additional detrimental impacts.

All temporary roads used (existing and new) for this project would be hydrologically obliterated after use. Subsoiling of temporary roads may occur as a post-sale area improvement activity where conditions are appropriate. Non-system roads that are used for project activities will be returned to their pre-use

condition. Rehabilitation of non-system roads used for project implementation, will be proposed for KV funding for improvement of hydraulic function, watershed condition, and soil productivity.

Several studies discuss the effectiveness of subsoiling as a soil restoration activity. Seedling survival and growth can be improved by 39 percent after decompacting soils (Froehlich and McNabb, 1983). Subsoiling restores biological processes that are reduced by soil compaction (Dick et al., 1988). In general, tilling or scarifying a compacted soil improves productivity by reducing the resistance of soil to root penetration and providing improved soil drainage and aeration to enhance seedling establishment and tree growth (Bulmer, 1998). These conditions also improve the environment for soil microorganisms. Soil restoration is not the immediate result of ripping, planting, or any other activity. The goal of soil restoration is to create favorable conditions for impaired soils to begin the recovery process.

Table 6. New Detrimental Soil Conditions for Alternative 2 and 3

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
	Alt 2	Alt 3	Alt 2	Alt 3	Alt 2	Alt 3	Alt 2	Alt 3	Alt 2	Alt 3
300	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
301	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
302	5%	5%	2%	2%	3%	3%	1.9%	1.9%	11%	11%
303	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
304	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
305	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
306	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
307	1%	1%	1%	1%	1%	1%	0.3%	0.3%	3%	3%
308	1%	1%	1%	1%	1%	1%	0.4%	0.4%	3%	3%
309	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
310	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
311	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
312	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
313	5%	5%	2%	2%	3%	3%	0.6%	0.6%	10%	10%
315	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
316	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
318	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
319	1%	1%	1%	1%	1%	1%	0.1%	0.1%	3%	3%
322	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
323	1%	1%	1%	1%	1%	1%	0.6%	0.6%	4%	4%
324	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
325	1%	1%	1%	1%	1%	1%	0.7%	0.7%	4%	4%
326	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
327	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
328	5%	5%	2%	2%	3%	3%	0.8%	0.8%	10%	10%
329	1%	1%	1%	1%	1%	1%	1.9%	1.9%	5%	5%
331	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
332	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
333	1%	1%	1%	1%	1%	1%	1.7%	1.7%	5%	5%
334	5%	5%	2%	2%	3%	3%	0.8%	0.8%	10%	10%
335	5%	5%	2%	2%	3%	3%	0.9%	0.9%	10%	10%
336	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
337	5%	5%	2%	2%	3%	3%	0.3%	0.3%	10%	10%
338	1%	1%	1%	1%	1%	1%	0.2%	0.2%	3%	3%
340	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
341	5%	5%	2%	2%	3%	3%	2.6%	2.6%	12%	12%
342	5%	5%	0%	0%	3%	3%	0.4%	0.4%	8%	8%
343	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
344	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
345	5%	5%	2%	2%	3%	3%	1.1%	1.1%	11%	11%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
346	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
347	5%	5%	2%	2%	3%	3%	2.4%	2.4%	12%	12%
348	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
349	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
351	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
352	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
354	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
355	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
356	1%	1%	1%	1%	1%	1%	0.7%	0.7%	4%	4%
357	1%	1%	1%	1%	1%	1%	0.4%	0.4%	3%	3%
358	1%	1%	1%	1%	1%	1%	0.8%	0.8%	4%	4%
359	5%	5%	2%	2%	3%	3%	2.9%	2.9%	12%	12%
360	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
361	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
363	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
364	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
365	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
366	5%	5%	2%	2%	3%	3%	0.8%	0.8%	10%	10%
367	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
369	1%	1%	1%	1%	1%	1%	0.1%	0.1%	3%	3%
370	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
371	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
372	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
373	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
374	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
375	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
376	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
377	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
378	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
379	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
380	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
381	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
382	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
383	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
384	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
385	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
387	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
391	5%	5%	2%	2%	3%	3%	1.5%	1.5%	11%	11%
392	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
393	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
394	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
395	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
397	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
399	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
400	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
401	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
402	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
403	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
404	1%	1%	1%	1%	1%	1%	0.8%	0.8%	4%	4%
405	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
406	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
407	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
408	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
409	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
410	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
411	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
412	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
413	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
414	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
415	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
416	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
418	5%	5%	2%	2%	3%	3%	1.5%	1.5%	11%	11%
419	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
421	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
422	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
423	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
425	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
426	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
427	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
428	1%	1%	1%	1%	1%	1%	1.6%	1.6%	5%	5%
429	5%	5%	2%	2%	3%	3%	1.6%	1.6%	11%	11%
431	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
432	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
433	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
434	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
435	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
436	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
437	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
438	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
440	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
442	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
443	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
444	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
445	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
446	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
447	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
450	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
451	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
452	5%	5%	2%	2%	3%	3%	0.3%	0.3%	10%	10%
453	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
454	1%	1%	1%	1%	1%	1%	0.9%	0.9%	4%	4%
456	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
457	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
458	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
460	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
463	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
464	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
465	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
466	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
468	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
469	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
471	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
472	1%	1%	1%	1%	1%	1%	0.4%	0.4%	3%	3%
473	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
474	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
476	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
477	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
478	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
482	5%	5%	2%	2%	3%	3%	0.8%	0.8%	10%	10%
483	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
484	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
485	5%	5%	0%	0%	3%	3%	0.7%	0.7%	8%	8%
489	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
491	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
492	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
493	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
494	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
495	1%	1%	0%	0%	1%	1%	0%	0%	2%	2%
496	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
498	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
499	1%	1%	1%	1%	1%	1%	0.6%	0.6%	4%	4%
501	1%	1%	0%	0%	1%	1%	0%	0%	2%	2%
502	1%	1%	0%	0%	1%	1%	0.8%	0.8%	3%	3%
505	1%	1%	0%	0%	1%	1%	0%	0%	2%	2%
507	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
508	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
510	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
511	5%	5%	0%	0%	3%	3%	0.4%	0.4%	8%	8%
512	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
513	5%	5%	0%	0%	3%	3%	0.4%	0.4%	8%	8%
519	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
520	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
521	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
523	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
524	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
525	1%	1%	1%	1%	1%	1%	0.8%	0.8%	4%	4%
526	5%	5%	2%	2%	3%	3%	1.7%	1.7%	11%	11%
531	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
532	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
533	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
534	5%	5%	2%	2%	3%	3%	1.1%	1.1%	11%	11%
536	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
537	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
538	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
539	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
541	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
542	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
544	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
545	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
546	5%	5%	2%	2%	3%	3%	0.3%	0.3%	10%	10%
548	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
550	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
554	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
555	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
556	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
557	1%	1%	1%	1%	1%	1%	1.1%	1.1%	4%	4%
558	5%	5%	2%	2%	3%	3%	0.3%	0.3%	10%	10%
559	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
560	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
561	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
563	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
569	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
571	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
572	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
575	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
576	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
578	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
579	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
582	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
583	5%	5%	2%	2%	3%	3%	1.2%	1.2%	11%	11%
584	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
585	5%	5%	2%	2%	3%	3%	0.8%	0.8%	10%	10%
586	5%	5%	2%	2%	3%	3%	1.0%	1.0%	11%	11%
587	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
700	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
701	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
702	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
703	0%	0%	0%	0%	0%	0%	0.3%	0.3%	0%	0%
704	0%	0%	0%	0%	0%	0%	0.5%	0.5%	1%	1%
705	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
706	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
707	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
708	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
709	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
710	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
711	0%	0%	0%	0%	0%	0%	0.1%	0.1%	0%	0%
712	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
713	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
715	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
716	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
719	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
720	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
721	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
722	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
723	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
724	0%	0%	0%	0%	0%	0%	0.2%	0.2%	0%	0%
725	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
726	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
727	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
900	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
902	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
904	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
905	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
906	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
907	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
909	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
910	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
911	0%	0%	1%	1%	0%	0%	0.1%	0.1%	1%	1%
912	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
914	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
917	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
919	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
920	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
923	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
924	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
925	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
927	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
929	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
930	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
931	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
932	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
933	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
935	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
937	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
938	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
939	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
941	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
942	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
943	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
944	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
946	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
947	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
948	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
949	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
950	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
951	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
952	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
953	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
954	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
955	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
957	0%	0%	2%	2%	0%	0%	0.4%	0.4%	2%	2%
958	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
959	0%	0%	1%	1%	0%	0%	0.2%	0.2%	1%	1%
960	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
961	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
962	0%	DROPPED	2%	DROPPED	0%	DROPPED	0.8%	0.8%	3%	1%
963	0%	0%	2%	2%	0%	0%	0.2%	0.2%	2%	2%
964	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
965	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
968	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
969	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
970	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
971	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
972	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
975	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
977	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
978	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
979	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
980	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
982	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
983	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
985	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
989	0%	0%	1%	1%	0%	0%	0.1%	0.1%	1%	1%
990	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
991	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
993	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
994	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
995	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
997	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1000	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1001	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1002	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1004	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1005	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1007	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1008	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1009	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1010	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1011	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1012	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1013	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1014	0%	0%	2%	2%	0%	0%	0.4%	0.4%	2%	2%
1015	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1016	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1017	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1018	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1019	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1020	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1021	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1024	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
1025	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1026	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1027	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1029	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1030	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1032	0%	0%	2%	2%	0%	0%	0.2%	0.2%	2%	2%
1033	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1035	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1036	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1037	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1038	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1040	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1044	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1045	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1047	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1050	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1053	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1054	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1055	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1057	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1058	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1059	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1061	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1063	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1067	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1068	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1069	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1070	0%	0%	2%	2%	0%	0%	0.4%	0.4%	2%	2%
1071	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1072	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1074	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1075	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1076	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1078	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1079	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1080	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1081	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1083	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1086	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1087	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1088	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1089	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1091	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1092	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1093	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1094	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1095	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1097	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1098	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1099	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1102	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1103	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1104	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1105	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1106	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1107	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1108	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1109	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
1110	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1111	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1112	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1113	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1114	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1116	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1117	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1118	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1119	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1121	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1122	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1123	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1124	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1126	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1128	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1130	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1131	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1132	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1133	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1134	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1136	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1139	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1142	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1143	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1144	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1145	0%	0%	2%	2%	0%	0%	0.5%	0.5%	3%	3%
1146	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1147	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1148	0%	0%	2%	2%	0%	0%	0.2%	0.2%	2%	2%
1149	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1150	0%	DROPPED	2%	DROPPED	0%	DROPPED	0.2%	0.2%	2%	0%
1151	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1152	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1153	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1154	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1155	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1156	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1157	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1158	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1160	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1161	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1163	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1164	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1166	0%	0%	2%	2%	0%	0%	0.6%	0.6%	3%	3%
1167	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1170	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1171	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1172	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1173	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1174	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1175	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1176	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1178	0%	0%	1%	1%	0%	0%	0.1%	0.1%	1%	1%
1179	0%	0%	2%	2%	0%	0%	0.3%	0.3%	2%	2%
1180	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1181	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1182	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1183	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
1184	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1185	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1186	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1187	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1188	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1189	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1190	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1191	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1192	0%	0%	2%	2%	0%	0%	0.1%	0.1%	2%	2%
1193	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1197	0%	DROPPED	1%	DROPPED	0%	DROPPED	0%	0%	1%	0%
1198	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1200	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1201	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1202	0%	0%	1%	1%	0%	0%	0%	0%	1%	1%
1203	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1204	0%	DROPPED	2%	DROPPED	0%	DROPPED	0%	0%	2%	0%
1205	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1206	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1207	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1208	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
1209	0%	0%	2%	2%	0%	0%	0%	0%	2%	2%
330A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
330B	5%	5%	2%	2%	3%	3%	3.9%	3.9%	13%	13%
339A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
339B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
350A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
350B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
350C	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
353A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
353B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
362A	5%	5%	2%	2%	3%	3%	1.8%	1.8%	11%	11%
362B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
368A	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
368B	5%	5%	2%	2%	3%	3%	0.9%	0.9%	10%	10%
385A	5%	5%	2%	2%	3%	3%	0.6%	0.6%	10%	10%
385B	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
386A	5%	5%	0%	0%	3%	3%	0.1%	0.1%	8%	8%
386B	5%	5%	0%	0%	3%	3%	0.2%	0.2%	8%	8%
388A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
388B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
388C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
389A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
389B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
389C	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
390A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
390B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
396A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
396B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
398A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
398B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
420A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
420B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
420C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
424A	5%	5%	2%	2%	3%	3%	3.4%	3.4%	13%	13%
424B	5%	5%	2%	2%	3%	3%	0.6%	0.6%	10%	10%
430A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
430B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
430C	1%	1%	1%	1%	1%	1%	0.5%	0.5%	3%	3%
430D	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
439A	1%	1%	1%	1%	1%	1%	0.1%	0.1%	3%	3%
439B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
441A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
441B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
448A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
448B	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
454A	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
459A	5%	5%	2%	2%	3%	3%	1.3%	1.3%	11%	11%
459B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
459C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
459D	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
461A	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
461B	5%	5%	2%	2%	3%	3%	0.5%	0.5%	10%	10%
461C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
462A	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
462B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
467A	5%	5%	2%	2%	3%	3%	0.6%	0.6%	10%	10%
467B	5%	5%	2%	2%	3%	3%	1.3%	1.3%	11%	11%
470A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
470B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
475A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
475B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
479A	5%	5%	0%	0%	3%	3%	0.6%	0.6%	8%	8%
479B	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
480A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
480B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
481A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
481B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
481C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
486A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
486B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
487A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
487B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
488A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
488B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
490A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
490B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
497A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
497B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
497C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
500A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
500B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
503A	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
503B	5%	5%	0%	0%	3%	3%	0.5%	0.5%	8%	8%
503C	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
504A	5%	5%	0%	0%	3%	3%	0.3%	0.3%	8%	8%
504B	5%	5%	0%	0%	3%	3%	0.2%	0.2%	8%	8%
504C	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
504D	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
506A	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
506B	5%	5%	0%	0%	3%	3%	0.4%	0.4%	8%	8%
506C	5%	5%	0%	0%	3%	3%	0%	0%	8%	8%
509A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
509B	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
514A	5%	5%	2%	2%	3%	3%	1.3%	1.3%	11%	11%
514B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
515A	5%	5%	2%	2%	3%	3%	1.0%	1.0%	11%	11%
515B	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
516A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
516B	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
517A	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
517B	5%	5%	2%	2%	3%	3%	0.4%	0.4%	10%	10%
518A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
518B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
522A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
522B	5%	5%	2%	2%	3%	3%	2.6%	2.6%	12%	12%
522C	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
522D	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
522E	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
527A	5%	5%	2%	2%	3%	3%	2.6%	2.6%	12%	12%
527B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
527C	5%	5%	2%	2%	3%	3%	1.4%	1.4%	11%	11%
527D	5%	5%	2%	2%	3%	3%	2.0%	2.0%	12%	12%
528A	1%	1%	1%	1%	1%	1%	0.2%	0.2%	3%	3%
528B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
529A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
529B	5%	5%	2%	2%	3%	3%	0.9%	0.9%	10%	10%
529C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
530A	5%	5%	2%	2%	3%	3%	1.6%	1.6%	11%	11%
530B	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
535A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
535B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
540A	5%	5%	2%	2%	3%	3%	1.0%	1.0%	10%	10%
540B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
543A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
543B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
547A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
547B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
547C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
547D	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
549A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
549B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
551A	5%	5%	2%	2%	3%	3%	0.6%	0.6%	10%	10%
551B	5%	5%	2%	2%	3%	3%	1.0%	1.0%	10%	10%
551C	5%	5%	2%	2%	3%	3%	0.3%	0.3%	10%	10%
551D	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
552A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
552B	5%	5%	2%	2%	3%	3%	1.7%	1.7%	11%	11%
554A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
558A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
562A	5%	5%	2%	2%	3%	3%	0.7%	0.7%	10%	10%
562B	5%	5%	2%	2%	3%	3%	0.3%	0.3%	10%	10%
562C	5%	5%	2%	2%	3%	3%	1.0%	1.0%	11%	11%
564A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
564B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
564C	5%	5%	2%	2%	3%	3%	0.1%	0.1%	10%	10%
565A	1%	1%	1%	1%	1%	1%	0.6%	0.6%	4%	4%
565B	1%	1%	1%	1%	1%	1%	2.7%	2.7%	6%	6%
566A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
566B	5%	5%	2%	2%	3%	3%	0.2%	0.2%	10%	10%
567A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
567B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
568A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
568B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%

Unit	Skid Trail Contribution		Piling and Burning		Landings		Temporary Roads		New DSC	
570A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
570B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
573A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
573B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
574A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
574B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
574C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
574D	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
574E	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
577A	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
577B	1%	1%	1%	1%	1%	1%	0%	0%	3%	3%
580A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
580B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
581A	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
581B	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%
581C	5%	5%	2%	2%	3%	3%	0%	0%	10%	10%

In Alternative 2, there are 21,880 acres of droughty soil types that will be treated. In Alternative 3, there are 19,298 acres of droughty soil types that will be treated. Treatment on droughty soils will help restore soil moisture and plant community ecological processes to adapt to climate change and build forest resiliency.

There are 2,113 acres of shallow soils (<25cm), considered sensitive, within Alternative 2 activity areas. In Alternative 3, there are 2,003 acres of shallow soils (<25cm), considered sensitive. Project design criteria specifies shallow soils and meadows will be avoided unless over ground/snow conditions. Shallow soils won't be used for skid trails, slash piles, or log landings unless no other location is practical and there is an existing prism, in which case ground-based equipment will remain within the existing prism as much as possible (Soil PDC 4 and 7).

There are 504 acres of clay-dominated soils in Alternative 2 activity areas and are considered a sensitive soil type. In Alternative 3, there are 462 acres of clay-dominated soils in proposed activity areas and are considered a sensitive soil type. Clay soils tend to hold onto moisture and are not appropriate for road use (Soil PDC 4). Operation on these soils will only occur during frozen ground/snow or dry conditions to mitigate compaction and rutting (Soil PDC 3 and 4).

Alternative 2 has 10,715 acres of thick ash cap soils. Alternative 3 has 9,476 acres of thick ash cap soils. These soils are characterized with low bulk density, high porosity, and high-water holding capacity. They tend to be non-cohesive and because of their relatively low strength, are highly susceptible to both vibratory and compressive compaction. Controlling compaction involves use of low impact equipment selection, use of designated skid trails, and limitation of operations to dry seasons or when the ground is frozen. Ground-based activities on ash soils will be mitigated by only operating when ground conditions are dry, frozen, or snow covered (Soil PDC 3).

Alternative 2 has 8,325 acres of soils with an excess of soil moisture either yearlong or on a seasonal basis. Alternative 3 has 7,431 acres of sensitive soils with an excess of soil moisture either yearlong or on a seasonal basis. These soils have an increased potential for compaction and deep rutting and require special design criteria. Spring and early summer harvest on these soils will be avoided, and if this is not possible, ground-based equipment will operate on a bed of slash maintained at >12 inches to mitigate compaction and rutting as much as possible (Soil PDC 5).

In Alternative 2, there are 774 acres of hydric soils, which are wetland soils formed under saturated conditions. In Alternative 3, there are 221 acres of hydric soils, which are wetland soils formed under saturated conditions. When identified during implementation, these soils would be buffered appropriately as wetlands to meet national and regional laws and regulations (see Aquatics Report).

Organic Matter

All proposed treatments would leave varying amounts of organic matter on site. Reductions in organic matter content reverse quickly as vegetation is established. Organic debris accumulates on the surface and roots grow and are decomposed in the soil. These organic materials break down, release nutrients and improve the quality of the soil by improving its structure, reducing compaction and other DSCs. Coarse woody debris (greater than three inches in diameter) would be retained at approximately 5 to 10 tons per acre on dry ponderosa pine sites and 7 to 15 tons per acre on mixed conifer sites (Adapted from DeBano, Neary, and Ffolliott, 1998) (Soil PDC 11). The total amount of nutrients on a site would likely be reduced where organic matter would be removed or displaced. However, plant available nutrients mineralized from organic matter would increase due to increased incoming solar radiation and soil moisture. These conditions would accelerate the decomposition of the remaining organic matter and the release of plant-available nutrients in the treated stands (Harvey et al., 1994). After project implementation, competition between trees would be reduced because fewer trees would remain on the sites. This situation could result in more available nutrients and water for remaining trees, potentially contributing great growth, vigor and disease resistance (Power et al., 2005). Nutrients in soil and organic matter, are not the only nutrients available to forest vegetation. In logging followed by low-severity broadcast burning, there would be no long-term depletion of nitrogen reserves because lost nitrogen would be more than replenished by inputs from precipitation and by biological nitrogen fixation over a rotation of 100 to 150 years (Jurgensen et al., 1981).

Commercial Thinning and Mechanical Slash Treatment

These treatments would leave a large portion of the existing stand on site. Units proposed for grapple pile burning or prescribed fire would leave nutrients associated with the slash on site, to be used by the remaining forest vegetation. Grapple piling associated with NCT and PCT treatments would reduce organic material on sites while reducing hazardous fuel loads (USDA, 2005). Physical forest floor impacts would be limited to track deformation and minor amounts of displacement (less than 100 square feet). A variety of organic material would remain on the site after project implementation.

Under Alternative 2, there are 1,196 acres of low productivity soils proposed for treatment, not capable of producing or maintaining adequate fine organic matter if slash is removed. Under Alternative 3, there are 889 acres of low productivity soils proposed for treatment, not capable of producing or maintaining adequate fine organic matter if slash is removed. Special design criteria will mitigate potential loss of organics on these soils, by ensuring adequate amounts of fine slash is left on site (Soil PDC 16).

Hand Non-Commercial and Post-Commercial Thinning

Limiting hand pile size to less than 50 square feet could reduce surface organic horizon loss and limit soil heating. Pile burning when duff is moist or wet can reduce organic matter loss and soil heating (Soil PDC 15).

The amount of nutrients lost as particulate matter would be minor. Ash from burned hand piles would contain nutrients available to emergent vegetation, but no significant increases in nitrogen and phosphorus are anticipated (Seymour et al., 2005).

Prescribed Fire

The effect of fire on soil is described as burn severity, which depends on the duration of burning and the intensity (Certini, 2005). Long-duration burns tend to reach higher temperatures and penetrate deeper into soil, resulting in more soil microbial kill and consumption of soil organic matter (ibid.). These burns result from burning of heavy ground fuel, such as with downed logs and large slash piles. Short duration burning could be associated with fast-moving wildfire that blackens all the trees but leaves some of the forest floor intact. This usually results in low-to-moderate burn severities on the ground, with heat only penetrating a few centimeters (Harford et al., 1992). Prescribed fire activities that result in predominantly low-to-moderate burn severities would preserve soil productivity (Harvey et al., 1993). The amount of nutrients available to plants would increase as a result of the burning. Areas burned under conditions that produce light or moderate burn severity would vegetate quickly due to viable seeds or roots that could produce more plants and the benefit of microorganisms and nutrients remaining on site (Ryan and Noste, 1985; Harmon, 1992; Neary et al., 2005). Post-fire vegetation response would utilize available nutrients, reducing nutrient leaching. Native forest vegetation would remain on the site, including some of the existing trees.

The ultimate goal of this effort is to maximize the intended vegetative response while minimizing resource effects. Fire intensity represents the magnitude of produced heat (Keeley, 2009). It is distinct from burn severity. Fire management personnel would design burn plans and implement burning activities to minimize the occurrence of high-burn severity, while achieving burn intensities adequate to meet objectives.

Summary

All proposed units would leave live vegetation. Most of the living grass, forb, and shrub components would be retained in all of the proposed activity areas. Many live trees would remain on all of the sites. The material that remains in all of the activity areas would provide an active, microorganism-rich organic layer on the soil surface.

Limiting hand pile size to less than 50 square feet could reduce surface organic horizon loss and limit soil heating. Pile burning when duff is moist or wet can reduce organic matter loss and soil heating (Soil PDC 15).

Under Alternative 2, there are 1,196 acres of low productivity soils not capable of producing or maintaining adequate fine organic matter if slash is removed. Under Alternative 3, there are 889 acres of low productivity soils not capable of producing or maintaining adequate fine organic matter if slash is removed. Special design criteria will mitigate potential loss of organics on these soils by ensuring fine slash is left on site (Soil PDC 16).

Soil Biological Activity

The variety of organic matter left on the proposed activity areas would benefit soil microorganisms by providing substrate and habitat. Microbial measures in harvest areas are expected to meet, or exceed, levels in unharvested stands within 40 years (Page-Dumroese et al., 2015). All alternatives would leave both dead and live trees. All alternatives and all proposed activity areas would have less than 20 percent of the area detrimentally disturbed. Many areas would be undisturbed by equipment. These areas would be a source of propagules in disturbed sites. Both action alternatives describe the amount of live and dead trees to be left in proposed activity areas.

Post-fire recovery of soil microorganisms occurs rapidly, frequently resulting in population levels greater than before the fire (Jurgensen et al., 1979). Less disturbed areas of soil play an important role in inoculating soil lacking or having reduced populations of soil microorganisms (Borchers and Perry, 1990). Areas within burns that are left unburned, adjacent undisturbed areas, large woody debris and soils

with minor amounts of disturbance contain propagules for fungi, bacteria and other soil organisms. Wind, animals and other agents can freely disperse these propagules (Borchers and Perry, 1990).

Forest productivity depends on mycorrhizae for survival. Mycorrhizal fungi, like all fungi, are aerobes associated with the organic matter components of surface soils. Presumably, management activities that reduce aeration or soil organic matter (mechanical slash piling, and slash burning) will reduce mycorrhiza activity (Perry and Rose, 1983). Soil compaction, puddling, rutting, and displacement reduce gas exchange and could potentially affect soil microorganism survival. Favorable habitat for soil organisms will be maintained since all proposed activity areas would be designed to reduce soil disturbance to meet Region 6 Soil Quality Standards.

Summary

Because the amount of detrimental physical soil changes would be minimized and because organic matter in various forms would remain on the proposed units, the effects to soil microorganisms would be minor. Soil microorganisms are mobile. They can quickly re-colonize disturbed sites from adjacent, undisturbed sites. A variety of organic matter would remain on all sites, including living trees and other forest vegetation. In addition, the organic layer on the soil surface would be retained over at least 80 percent of the area, providing habitat and nutrients for soil microorganisms.

Soil Erosion

Displacement and erosion, the loss of topsoil, is a long-term and perhaps a permanent loss of soil productivity. However, management practices outline in the Project Design Criteria would reduce the occurrence of displacement and erosion to within the Region 6 Soil Quality Standards. Where there is a risk of soil erosion, it would be minimized by implementing the following management practices:

- Reducing the area where equipment operates,
- Locating landings on relatively flat ground that can be properly drained,
- Locating skid trails on slopes less than 30 percent that have soils with a low or moderate erosion hazard,
- Using erosion control features, such as water bars, replanting, and placing slash on disturbed soils.

Alternative 2 and 3 treatments for each hillslope were modeled to determine potential erosion after both thinning and prescribed fire treatments. Alternative 2 mean average annual soil loss is 0.14 tons per acre (Table 7). The 30-year return period analysis estimates up to 10% probability of 0.16 tons per acre of erosion within the first year following implementation of treatments. Alternative 3 mean average annual soil loss is 0.09 tons per acre (Table 7). The 30-year return period analysis estimates up to 10% probability of 0.08 tons per acre of erosion within the first year following implementation of treatments. By way of comparison, the average annual erosion on Oregon cropland in 2015 was 1.7 tons per acre per year. A ton of soil spread across an acre would be as thick as a dime.

Erosion potential is highest within the first year following ground-disturbance, wildfire, or prescribed fire. This project will be implemented across approximately 10 to 15 years. This makes it very likely that actual erosion rates across the project area will be less than modeled.

Table 7. Potential Soil Erosion modeled in WEPP for Alternative 2 and 3

Alternative	Potential Erosion Rate (tons/acre)	Potential Total Erosion (tons)
No Action	0.0	0.0
Alt 2	0.14	9.4
Alt 3	0.09	5.7

Sediment from the permanent transportation system has direct effects on water quality and is not a component of the soil quality assessment process. These effects are evaluated in the Hydrology Section of this EA.

Commercial Thinning and Mechanical Slash Treatment

Management activities that leave organic matter on the soil surface reduce soil erosion potential (Megahan, 1981; Megahan, 1986; Robichaud et al., 1993). The dominant surface erosion hazard when the forest floor has been disturbed, with ground-based proposed is slight to moderate.

Alternative 2 has 6,944 acres and Alternative 3 has 6,173 acres of soil types (>1 acre in size) with high erosion hazard. Alternative 2 has 4,130 acres and Alternative 3 has 3,597 acres of soil types (>1 acre in size) with very high erosion hazard.

Together, soils with high and very high erosion potential make up 39% of ground-based activities in Alternative 2 and 33% of ground-based activities in Alternative 3. To reduce surface erosion potential, disturbed areas within these units would be required to have a minimum of 60 to 90 percent effective ground cover following cessation of any soil-disturbing activities (R6 Soil Quality Standard) (Soil PDC 12). Any increase in overland flow from existing areas of compacted soil is likely to be buffered by existing forest floor and/or new accumulations of woody debris.

Hand Non-Commercial and Post-Commercial Thinning

Maintenance of infiltration rates and effective ground cover of soils is necessary to prevent erosion. The lack of compactive forces would not result in a significant reduction in infiltration rates over undisturbed soil. Although reductions in effective ground cover would be expected at burn pile locations, the lack of accompanying increase in overland flow and the rapid establishment of live plant cover would reduce short-term soil erosion. No long-term soil erosion is anticipated from this treatment. Soil erosion would be unlikely to occur because of the small diameter thinning treatments.

Prescribed Fire

Landscape burning would leave many areas unburned, providing a buffer for any increase in overland flow. Post-fire vegetative response would be rapid, regardless of burn severity and areas that burn intensely would have sufficient organic material and vegetative response to reduce risks to soil erosion (Robichaud and Waldrop, 1994; Robichaud and Brown, 1999; Lentile et al., 2007). Soil erosion rates would decrease, as vegetation and effective ground cover are re-established. It is recommended that this project utilizes extended burn periods so that only portions of the watershed are incrementally impacted over the intended time frame. This should allow burned areas to recover and potential sediment movement or delivery to be minimal, especially if riparian buffers are maintained.

Temporary Roads

Erosion is expected from temporary roads, where native surfaces are exposed to rainfall impact and overland flow. In Alternatives 2 and 3, there are 26 miles of temporary roads proposed on soils with high

erosion hazard when used as native surface roads or trails. These roads would likely have short-term increases of soil erosion above 2 tons per acre per year. Erosion rates would decrease, as roads are obliterated immediately following use. All ground-disturbing activities are required to have the minimum effective ground cover after completion of activities, in order to prevent erosion from exceeding background erosion rates. When prescribed burning is utilized after recontouring temporary roads, the slash and organic material that has to be incorporated into the road rehabilitation should not be burned (Soil PDC 14 and 15).

Road Maintenance and Reconstruction

Road maintenance is planned for most open roads in the project. Maintenance will also occur on stored roads needed to access designated treatment areas. Road maintenance activities include replacement of existing culverts, cleaning road drainage features including ditches, culverts and dips, full depth reconditions of the road prism, road base stabilization, fill slope stabilization, clearing and brushing of existing right of way, removal of tree stumps within the travel way, road grading, and placing new road surface aggregate. Culvert installations and replacements would cause some short-term soil erosion during the construction phase but would result in improved road drainage and a reduction of road failure risk during high flow events (Burroughs, 1989). Removal of tree stumps, referred to as stump grubbing, is done when opening a closed road, or an open system road that has trees within the road prism. Stump grubbing is only done in order to allow for road grading within drivable road template. It is expected to cause some short-term soil erosion, similar to road grading.

Road reconstruction activities will remain within the existing road prism. Reconstruction activities include replacement of stream crossing structures (e.g., major culverts and bridges), and realignment of less than 0.5 miles in length of existing roads where significant safety, transportation or hydrologic concerns exist. Road relocation and realignment completely removes a road from areas of concern or changes the placement to reduce or eliminate negative impacts caused by the road on the surrounding ecosystems. One road proposed for realignment is within an RHCA along a stream which is producing sediment to the stream and eroding the road template. Realignment requires removal of enough of the old road prism to allow the surface and subsurface water drainage networks to regain their natural function and pattern. Heavy equipment (dozers, compactors, graders, and excavators) are used for removal and reconstruction. Benefits of realigning a road include restored flood plain structure and function, and reduced risks of road failures from catastrophic storm events. Realignment can cause considerable disturbance to an area and short-term increased soil erosion but would result in improved road drainage and reduced road failure risk during high flow events. Techniques to help reduce negative effects to riparian areas are soil bioengineering, landslide mitigation strategies (Soil PDC 10), and erosion control devices (i.e., sediment barriers, retention structures, and mulches or erosion fabrics). Long-term erosion would decrease after road realignment since the road will be moved away from Gimlet Creek and road design will be improved. Other road segments, also less than 0.5 miles in length, may be identified for realignment prior to project implementation, and would follow the PDCs, therefore the expected effects would be similar to those described above.

Soil Stability

A majority of the project area has high rates of slope stability and are well-suited for proposed activities. The majority of ground-based treatments are planned for areas with slopes less than 30 percent, which greatly reduces the risk of mass failures. The occurrence of any mass-failure occurring on well-suited slopes as a result of implementation of proposed actions is unlikely.

Proposed Treatments

In Alternative 2, there are 1,651 acres of proposed treatments on slopes with increased potential for landslides or existing landslides. In Alternative 3, there are 1,511 acres of proposed treatments on slopes with increased potential for landslides or existing landslides.

The headscarp of the landslide area on the 1040 road has a moderate likelihood of slope failures following post timber harvest. The rest of this landslide was determined to be low hazard and will likely not have significant stability problems due to harvesting. The headscarp area may have minor stability problems in the dry season, but no significant reduction in stability is expected. Soil PDC 10 requires that the area be monitored the first two years or following prolonged saturated periods within 5 years of a timber harvest and if it appears that landslide movement is occurring (slumping, change in slope, etc), then a field inspection should be done by a qualified Professional Engineer (Soil PDC 10).

Other landslide areas with low hazard level include sites along the 1042-105 road and the 1046-35 road. Normal logging practices will not significantly decrease terrain stability (See Geotechnical Engineering Report).

Other landslide areas with moderate to high hazard level include sites along the 7380 road, 1046-160 road, and the 1055-300 road. It is recommended these areas have at least a Terrain Survey Intensity Level (TSIL) - D assessment to better define recommendations. There is a high likelihood that slope failures will occur post logging especially if all trees are removed (Soil PDC 10). Due to recent landslide activity evidence and landslide mapping, the hazard area along the 7380 road has a moderate to high risk of creep, slumping and earthflows. A field inspection of these areas should be made by a qualified specialist prior to project activities in order to assess the stability of the terrain in detail, which may reduce the hazard level in some or all areas (Soil PDC 10). As a mapped landslide composed of a fine-grained sedimentary geology, RD 1046-160 has a moderate-high risk for slump or earthflows. No recent movement is visible from aerials, but field verification would be required in order to reduce the hazard level (Soil PDC 10). On the northwest slopes of RD 1055-300, there is a possibility of rockfall, but due to the unknown properties of the rock, the hazard level of high was chosen to be on the conservative side. The head of the slide is mapped on SLIDO as part of a large landslide and due to its fine-grained sedimentary geology, a moderate-high hazard level was chosen for the entire landslide. After a field investigation by a professional engineer, this hazard may be reduced (Soil PDC 10).

Road Activities

In Alternative 2 and 3, there are 5 miles of temporary roads proposed on landslide prone areas. The 1040 RD landslide will have no road construction near the headscarp during the wet season or near any wet areas with slopes greater than 30 degrees (Soil PDC 10). It is also recommended that the area be monitored years following a timber harvest and if it appears that landslide movement is occurring (slumping, change in slope, etc), then a field inspection should be done by a professional engineer (See Geotechnical Engineering Report).

Other landslide areas with low hazard level include sites along the 1042-105 road and the 1046-35 road. Normal road construction will not significantly decrease terrain stability. Periodic maintenance of ditches is expected due to sloughing along road cuts. It should be noted that RD 1046-35 lies within two intersecting faults. If this had been a landslide, it likely would have been triggered by a seismic activity since the area is fairly dry and has no sign of movement (Soil PDC 10).

Other landslide areas with moderate to high hazard level include sites the 7380 road, 1046-160 road, and the 1055-300 road. It is recommended these areas have at least a Terrain Survey Intensity Level (TSIL) D assessment to better define recommendations. These areas will have no new road construction during wet season or when the ground is saturated due to high likelihood of slope failures (Soil PDC 10). Due to recent landslide activity evidence and landslide mapping, the hazard area along the 7380 road has a

moderate to high risk of creep, slumping and earthflows. A field inspection of these areas should be made by a qualified specialist prior to any new road construction in order to assess the stability of the terrain in detail which may reduce the hazard level in some or all areas (Soil PDC 10). As a mapped landslide composed of a fine-grained sedimentary geology, RD 1046-160 has a moderate-high risk for slump or earthflows. No recent movement is visible from aerials, but field verification would be required in order to reduce the hazard level (Soil PDC 10). On the northwest slopes of RD 1055-300, there is a possibility of rockfall, but due to the unknown properties of the rock, the hazard level of high was chosen to be on the conservative side. The head of the slide is mapped on SLIDO as part of a large landslide and due to its fine-grained sedimentary geology, a moderate-high hazard level was chosen for the entire landslide. After a field investigation by a professional engineer, this hazard may be reduced (Soil PDC 10).

Cumulative Effects

The risk of cumulative effects was assessed within each proposed activity area. Cumulative effects consist of the impacts from all past, present, future, and proposed activities overlapping in time and space within the project area. The estimated cumulative effects for each activity area from implementation of an action alternative are displayed in Table 8. These predicted cumulative detrimental soil condition values are based on implementation of all required Project Design Criteria (PDC). See associated PDCs for the Soil Resource in Chapter 2.

Noxious Weed Management will overlap in time and space with this project, however, does not create any ground disturbance and therefore is unmeasurable. The Wildlife Enhancement Closure Area would reduce OHV and cross-country travel within the closure area for part of the year, which reduces the potential for soil impacts. Dispersed camping occurs primarily during hunting season and can occur throughout the project area since there is currently no restriction on cross-country motorized travel. Dispersed camping could create limited areas of soil compaction and displacement but would be too limited in aerial extent to measure. The large winter and summer trailhead, Blue Springs Summit is used by motorized trail users, skiers and snowmobilers. Trail maintenance could create limited areas of soil displacement and puddling but would be too limited in aerial extent to measure, and unlikely to measurably increase in the foreseeable future. OHV use within the project area occurs on 10 miles of trail #01972, however OHV use is permitted on most roads within the project area and cross-country. Cross-country travel and OHV could create limited areas of soil compaction, displacement and puddling but would be too limited in aerial extent to measure and unlikely to measurably increase in the foreseeable future. Firewood cutting and Danger Tree Removal could create limited areas of soil compaction, displacement, and puddling from skidding trees and off-road wood retrieval but would be too limited in aerial extent to measure. Road maintenance occurs only within the road prism right-of-way is not part of the productive land base, therefore soil productivity concerns are not applicable. National BMPs will be implemented to ensure erosion control measures and slope stability. Road maintenance improves long-term road drainage and sediment delivery concerns. The Wallowa-Whitman Travel Management Plan would manage cross-country motor vehicle use and limit use to designated roads, trails, and other areas. This would allow user-created roads and trails to recover and grow back over. This would increase soil productivity and reduce soil erosion caused by ground-cover removal from cross-country travel. Additionally, there is potential for additional access for cattle into project units that were previously inaccessible, however impacts would be too limited in aerial extent to measure. There is currently active grazing in the Alder Springs, Elmwood, Hale, North Burnt River, Snow Creek, Upper Middle Fork, West Burnt River and Whitney Range Allotment. Most grazing impacts are within riparian areas and water development areas. Grazing impacts could occur within areas of riparian proposed activities, however fencing will be used to mitigate any potential effects from grazing. Grazing impacts near water development areas could have limited areas of compaction or trampling of soil, however the potential soil impact would be too limited in aerial extent to be counted in DSC calculations (Page 3 of Region 6 Supplement No. 2500.98-1, USDA

Forest Service, 1998). These ongoing and reasonably foreseeable activities are not expected to add to adverse cumulative watershed effects for the soil resource because of their limited aerial extent.

Table 8. Cumulative Effects for Both Action Alternatives

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
		Alt 2	Alt 3	Alt 2	Alt 3	Alt 2	Alt 3
300	3%	10%	10%	0%	0%	13%	13%
301	3%	10%	10%	0%	0%	13%	13%
302	6%	10%	10%	2%	2%	17%	17%
303	10%	10%	10%	0%	0%	19%	19%
304	5%	10%	10%	0%	0%	15%	15%
305	4%	10%	10%	0%	0%	13%	13%
306	3%	3%	3%	0%	0%	6%	6%
307	5%	3%	3%	0%	0%	9%	9%
308	8%	3%	3%	0%	0%	12%	12%
309	3%	3%	3%	0%	0%	6%	6%
310	3%	3%	3%	0%	0%	6%	6%
311	4%	3%	3%	0%	0%	7%	7%
312	3%	3%	3%	0%	0%	6%	6%
313	3%	10%	10%	1%	1%	13%	13%
315	11%	10%	10%	0%	0%	21%	21%
316	4%	10%	10%	0%	0%	14%	14%
318	3%	10%	10%	0%	0%	13%	13%
319	3%	3%	3%	0%	0%	6%	6%
322	3%	10%	10%	0%	0%	13%	13%
323	7%	3%	3%	1%	1%	11%	11%
324	3%	10%	10%	0%	0%	13%	13%
325	4%	3%	3%	1%	1%	7%	7%
326	5%	10%	10%	0%	0%	15%	15%
327	3%	10%	10%	0%	0%	13%	13%
328	3%	10%	10%	1%	1%	14%	14%
329	3%	3%	3%	2%	2%	8%	8%
331	3%	3%	3%	0%	0%	6%	6%
332	3%	10%	10%	0%	0%	13%	13%
333	6%	3%	3%	2%	2%	11%	11%
334	6%	10%	10%	1%	1%	16%	16%
335	9%	10%	10%	1%	1%	20%	20%
336	3%	3%	3%	0%	0%	6%	6%
337	11%	10%	10%	0%	0%	21%	21%
338	4%	3%	3%	0%	0%	7%	7%
340	3%	3%	3%	0%	0%	6%	6%
341	5%	10%	10%	3%	3%	17%	17%
342	10%	8%	8%	0%	0%	18%	18%
343	3%	10%	10%	0%	0%	13%	13%
344	3%	10%	10%	0%	0%	13%	13%
345	3%	10%	10%	1%	1%	14%	14%
346	3%	10%	10%	0%	0%	13%	13%
347	3%	10%	10%	2%	2%	15%	15%
348	4%	10%	10%	0%	0%	14%	14%
349	4%	10%	10%	0%	0%	13%	13%
351	3%	10%	10%	0%	0%	13%	13%
352	3%	3%	3%	0%	0%	6%	6%
354	3%	10%	10%	0%	0%	13%	13%
355	3%	10%	10%	0%	0%	13%	13%
356	3%	3%	3%	1%	1%	7%	7%
357	3%	3%	3%	0%	0%	7%	7%
358	3%	3%	3%	1%	1%	7%	7%
359	4%	10%	10%	3%	3%	17%	17%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
360	3%	10%	10%	0%	0%	13%	13%
361	4%	10%	10%	0%	0%	13%	13%
363	3%	10%	10%	0%	0%	13%	13%
364	3%	10%	10%	0%	0%	13%	13%
365	3%	10%	10%	0%	0%	13%	13%
366	3%	10%	10%	1%	1%	14%	14%
367	3%	10%	10%	0%	0%	13%	13%
369	3%	3%	3%	0%	0%	6%	6%
370	3%	3%	3%	0%	0%	6%	6%
371	9%	10%	10%	0%	0%	18%	18%
372	6%	10%	10%	0%	0%	16%	16%
373	10%	10%	10%	0%	0%	19%	19%
374	5%	10%	10%	0%	0%	15%	15%
375	4%	10%	10%	0%	0%	14%	14%
376	3%	10%	10%	0%	0%	13%	13%
377	3%	10%	10%	0%	0%	13%	13%
378	3%	10%	10%	0%	0%	13%	13%
379	3%	10%	10%	0%	0%	13%	13%
380	15%	10%	10%	0%	0%	25%	25%
381	7%	10%	10%	0%	0%	16%	16%
382	4%	10%	10%	0%	0%	14%	14%
383	14%	10%	10%	0%	0%	23%	23%
384	11%	10%	10%	0%	0%	21%	21%
385	3%	10%	10%	0%	0%	13%	13%
387	4%	10%	10%	0%	0%	14%	14%
391	3%	10%	10%	2%	2%	14%	14%
392	3%	10%	10%	0%	0%	13%	13%
393	10%	10%	10%	0%	0%	20%	20%
394	11%	8%	8%	0%	0%	18%	18%
395	10%	10%	10%	0%	0%	20%	20%
397	4%	10%	10%	0%	0%	14%	14%
399	12%	3%	3%	0%	0%	15%	15%
400	10%	10%	10%	0%	0%	20%	20%
401	4%	10%	10%	0%	0%	14%	14%
402	4%	10%	10%	0%	0%	14%	14%
403	7%	10%	10%	0%	0%	17%	17%
404	3%	3%	3%	1%	1%	7%	7%
405	6%	10%	10%	0%	0%	16%	16%
406	3%	10%	10%	0%	0%	13%	13%
407	3%	10%	10%	0%	0%	13%	13%
408	3%	10%	10%	0%	0%	13%	13%
409	9%	10%	10%	0%	0%	18%	18%
410	3%	10%	10%	0%	0%	13%	13%
411	9%	10%	10%	0%	0%	19%	19%
412	3%	10%	10%	0%	0%	13%	13%
413	4%	10%	10%	0%	0%	13%	13%
414	9%	10%	10%	0%	0%	19%	19%
415	12%	10%	10%	0%	0%	22%	22%
416	4%	10%	10%	0%	0%	13%	13%
418	3%	10%	10%	1%	1%	14%	14%
419	10%	10%	10%	0%	0%	19%	19%
421	10%	10%	10%	0%	0%	19%	19%
422	7%	10%	10%	0%	0%	17%	17%
423	5%	10%	10%	1%	1%	16%	16%
425	3%	10%	10%	0%	0%	13%	13%
426	4%	10%	10%	0%	0%	13%	13%
427	11%	10%	10%	0%	0%	21%	21%
428	6%	3%	3%	2%	2%	10%	10%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
429	4%	10%	10%	2%	2%	15%	15%
431	3%	10%	10%	1%	1%	14%	14%
432	12%	10%	10%	1%	1%	22%	22%
433	5%	10%	10%	0%	0%	14%	14%
434	12%	10%	10%	0%	0%	21%	21%
435	7%	10%	10%	0%	0%	16%	16%
436	3%	10%	10%	0%	0%	13%	13%
437	8%	10%	10%	0%	0%	17%	17%
438	7%	10%	10%	0%	0%	16%	16%
440	3%	10%	10%	0%	0%	13%	13%
442	3%	10%	10%	0%	0%	13%	13%
443	3%	3%	3%	0%	0%	6%	6%
444	7%	10%	10%	0%	0%	16%	16%
445	11%	3%	3%	0%	0%	14%	14%
446	4%	3%	3%	0%	0%	7%	7%
447	3%	10%	10%	0%	0%	13%	13%
450	7%	10%	10%	0%	0%	16%	16%
451	4%	10%	10%	0%	0%	14%	14%
452	4%	10%	10%	0%	0%	14%	14%
453	3%	10%	10%	0%	0%	13%	13%
454	3%	3%	3%	1%	1%	7%	7%
456	3%	10%	10%	0%	0%	13%	13%
457	3%	10%	10%	0%	0%	13%	13%
458	3%	10%	10%	0%	0%	13%	13%
460	3%	10%	10%	0%	0%	13%	13%
463	3%	10%	10%	0%	0%	13%	13%
464	3%	10%	10%	0%	0%	13%	13%
465	13%	8%	8%	0%	0%	21%	21%
466	10%	10%	10%	0%	0%	20%	20%
468	4%	10%	10%	0%	0%	14%	14%
469	4%	3%	3%	0%	0%	7%	7%
471	4%	10%	10%	0%	0%	13%	13%
472	3%	3%	3%	0%	0%	7%	7%
473	3%	10%	10%	0%	0%	13%	13%
474	5%	10%	10%	0%	0%	15%	15%
476	4%	3%	3%	0%	0%	7%	7%
477	4%	10%	10%	0%	0%	13%	13%
478	4%	10%	10%	0%	0%	14%	14%
482	6%	10%	10%	1%	1%	17%	17%
483	3%	10%	10%	0%	0%	13%	13%
484	3%	10%	10%	0%	0%	13%	13%
485	3%	8%	8%	1%	1%	12%	12%
489	4%	10%	10%	0%	0%	14%	14%
491	12%	10%	10%	0%	0%	22%	22%
492	12%	10%	10%	0%	0%	21%	21%
493	6%	3%	3%	0%	0%	9%	9%
494	11%	10%	10%	0%	0%	20%	20%
495	4%	2%	2%	0%	0%	6%	6%
496	8%	3%	3%	0%	0%	11%	11%
498	15%	10%	10%	0%	0%	24%	24%
499	3%	3%	3%	1%	1%	7%	7%
501	3%	2%	2%	0%	0%	5%	5%
502	15%	2%	2%	1%	1%	18%	18%
505	15%	2%	2%	0%	0%	17%	17%
507	13%	8%	8%	0%	0%	20%	20%
508	13%	8%	8%	0%	0%	21%	21%
510	13%	10%	10%	0%	0%	23%	23%
511	13%	8%	8%	0%	0%	21%	21%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
512	10%	10%	10%	0%	0%	20%	20%
513	8%	8%	8%	0%	0%	16%	16%
519	14%	10%	10%	0%	0%	24%	24%
520	15%	10%	10%	0%	0%	25%	25%
521	15%	3%	3%	0%	0%	18%	18%
523	13%	10%	10%	0%	0%	23%	23%
524	4%	10%	10%	0%	0%	14%	14%
525	3%	3%	3%	1%	1%	7%	7%
526	5%	10%	10%	2%	2%	16%	16%
531	8%	10%	10%	0%	0%	17%	17%
532	4%	10%	10%	0%	0%	14%	14%
533	9%	10%	10%	0%	0%	19%	19%
534	13%	10%	10%	1%	1%	24%	24%
536	12%	10%	10%	0%	0%	21%	21%
537	13%	10%	10%	0%	0%	23%	23%
538	8%	10%	10%	0%	0%	18%	18%
539	3%	10%	10%	0%	0%	13%	13%
541	8%	10%	10%	0%	0%	18%	18%
542	10%	10%	10%	0%	0%	19%	19%
544	15%	10%	10%	0%	0%	24%	24%
545	15%	3%	3%	0%	0%	18%	18%
546	15%	10%	10%	0%	0%	25%	25%
548	15%	10%	10%	0%	0%	25%	25%
550	15%	10%	10%	0%	0%	25%	25%
554	5%	10%	10%	0%	0%	14%	14%
555	5%	10%	10%	0%	0%	15%	15%
556	3%	3%	3%	0%	0%	6%	6%
557	7%	3%	3%	1%	1%	11%	11%
558	5%	10%	10%	0%	0%	15%	15%
559	3%	10%	10%	0%	0%	13%	13%
560	14%	10%	10%	0%	0%	24%	24%
561	15%	10%	10%	0%	0%	24%	24%
563	3%	10%	10%	0%	0%	13%	13%
569	15%	10%	10%	0%	0%	25%	25%
571	3%	10%	10%	0%	0%	13%	13%
572	4%	10%	10%	0%	0%	13%	13%
575	6%	10%	10%	0%	0%	15%	15%
576	4%	10%	10%	0%	0%	14%	14%
578	3%	10%	10%	0%	0%	13%	13%
579	3%	10%	10%	0%	0%	13%	13%
582	3%	10%	10%	0%	0%	13%	13%
583	15%	10%	10%	1%	1%	26%	26%
584	4%	3%	3%	0%	0%	7%	7%
585	11%	10%	10%	1%	1%	21%	21%
586	11%	10%	10%	1%	1%	21%	21%
587	11%	10%	10%	0%	0%	20%	20%
700	10%	0%	0%	0%	0%	10%	10%
701	10%	0%	0%	0%	0%	10%	10%
702	7%	0%	0%	0%	0%	7%	7%
703	12%	0%	0%	0%	0%	12%	12%
704	6%	0%	0%	1%	1%	6%	6%
705	5%	0%	0%	0%	0%	5%	5%
706	13%	0%	0%	0%	0%	13%	13%
707	5%	0%	0%	0%	0%	5%	5%
708	12%	0%	0%	0%	0%	12%	12%
709	13%	0%	0%	0%	0%	13%	13%
710	13%	0%	0%	0%	0%	13%	13%
711	9%	0%	0%	0%	0%	9%	9%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
712	7%	0%	0%	0%	0%	7%	7%
713	12%	0%	0%	0%	0%	12%	12%
715	3%	0%	0%	0%	0%	3%	3%
716	3%	0%	0%	0%	0%	3%	3%
719	8%	0%	0%	0%	0%	8%	8%
720	11%	0%	0%	0%	0%	11%	11%
721	4%	0%	0%	0%	0%	4%	4%
722	3%	0%	0%	0%	0%	3%	3%
723	3%	0%	0%	0%	0%	3%	3%
724	5%	0%	0%	0%	0%	6%	6%
725	12%	0%	0%	0%	0%	12%	12%
726	6%	0%	0%	0%	0%	6%	6%
727	5%	0%	0%	0%	0%	5%	5%
900	15%	2%	2%	0%	0%	17%	17%
902	3%	1%	1%	0%	0%	4%	4%
904	15%	2%	2%	0%	0%	17%	17%
905	15%	2%	2%	0%	0%	17%	17%
906	6%	1%	1%	0%	0%	7%	7%
907	15%	1%	1%	0%	0%	16%	16%
909	5%	1%	1%	0%	0%	6%	6%
910	15%	2%	2%	0%	0%	17%	17%
911	8%	1%	1%	0%	0%	10%	10%
912	14%	2%	2%	0%	0%	16%	16%
914	15%	2%	2%	0%	0%	17%	17%
917	14%	1%	1%	0%	0%	15%	15%
919	12%	2%	2%	0%	0%	14%	14%
920	15%	1%	1%	0%	0%	16%	16%
923	4%	2%	2%	0%	0%	6%	6%
924	11%	2%	2%	0%	0%	13%	13%
925	3%	1%	1%	0%	0%	4%	4%
927	9%	1%	1%	0%	0%	10%	10%
929	3%	1%	0%	0%	0%	4%	3%
930	16%	2%	2%	0%	0%	18%	18%
931	13%	1%	1%	0%	0%	14%	14%
932	11%	2%	2%	0%	0%	13%	13%
933	6%	1%	1%	0%	0%	7%	7%
935	3%	2%	2%	0%	0%	5%	5%
937	11%	2%	2%	0%	0%	13%	13%
938	11%	2%	2%	0%	0%	13%	13%
939	13%	2%	2%	0%	0%	15%	15%
941	15%	2%	2%	0%	0%	17%	17%
942	15%	1%	1%	0%	0%	16%	16%
943	11%	2%	2%	0%	0%	13%	13%
944	12%	1%	1%	0%	0%	13%	13%
946	3%	2%	0%	0%	0%	5%	3%
947	3%	2%	2%	0%	0%	5%	5%
948	3%	2%	2%	0%	0%	5%	5%
949	3%	2%	0%	0%	0%	5%	3%
950	3%	1%	1%	0%	0%	4%	4%
951	3%	2%	2%	0%	0%	5%	5%
952	3%	2%	2%	0%	0%	5%	5%
953	3%	2%	2%	0%	0%	5%	5%
954	3%	2%	0%	0%	0%	5%	3%
955	3%	1%	1%	0%	0%	4%	4%
957	9%	2%	2%	0%	0%	11%	11%
958	3%	1%	0%	0%	0%	4%	3%
959	7%	1%	1%	0%	0%	8%	8%
960	15%	2%	2%	0%	0%	17%	17%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
961	13%	1%	1%	0%	0%	14%	14%
962	3%	2%	0%	1%	1%	6%	4%
963	6%	2%	2%	0%	0%	9%	9%
964	3%	1%	1%	0%	0%	4%	4%
965	3%	2%	2%	0%	0%	5%	5%
968	5%	2%	2%	0%	0%	7%	7%
969	12%	2%	2%	0%	0%	14%	14%
970	9%	2%	0%	0%	0%	11%	9%
971	14%	1%	1%	0%	0%	15%	15%
972	4%	2%	0%	0%	0%	6%	4%
975	3%	2%	2%	0%	0%	5%	5%
977	3%	1%	1%	0%	0%	4%	4%
978	10%	2%	2%	0%	0%	12%	12%
979	9%	2%	0%	0%	0%	11%	9%
980	14%	2%	2%	0%	0%	16%	16%
982	15%	2%	2%	0%	0%	17%	17%
983	3%	1%	1%	0%	0%	4%	4%
985	13%	1%	1%	0%	0%	14%	14%
989	3%	1%	1%	0%	0%	4%	4%
990	15%	2%	2%	0%	0%	17%	17%
991	11%	2%	2%	0%	0%	13%	13%
993	10%	2%	2%	0%	0%	12%	12%
994	9%	2%	2%	0%	0%	11%	11%
995	8%	2%	2%	0%	0%	10%	10%
997	9%	2%	2%	0%	0%	11%	11%
1000	15%	2%	2%	0%	0%	17%	17%
1001	9%	2%	2%	0%	0%	11%	11%
1002	3%	1%	1%	0%	0%	4%	4%
1004	15%	2%	2%	0%	0%	17%	17%
1005	12%	2%	2%	0%	0%	14%	14%
1007	3%	1%	1%	0%	0%	4%	4%
1008	9%	2%	2%	0%	0%	11%	11%
1009	3%	2%	2%	0%	0%	5%	5%
1010	3%	2%	2%	0%	0%	5%	5%
1011	14%	2%	2%	0%	0%	16%	16%
1012	8%	1%	1%	0%	0%	9%	9%
1013	3%	1%	1%	0%	0%	4%	4%
1014	4%	2%	2%	0%	0%	6%	6%
1015	4%	1%	1%	0%	0%	5%	5%
1016	9%	1%	1%	0%	0%	10%	10%
1017	10%	2%	2%	0%	0%	12%	12%
1018	10%	2%	2%	0%	0%	12%	12%
1019	8%	2%	2%	0%	0%	10%	10%
1020	10%	2%	2%	0%	0%	12%	12%
1021	15%	1%	1%	0%	0%	16%	16%
1024	6%	2%	2%	0%	0%	8%	8%
1025	13%	2%	2%	0%	0%	15%	15%
1026	4%	2%	2%	0%	0%	6%	6%
1027	14%	2%	2%	0%	0%	16%	16%
1029	5%	2%	0%	0%	0%	7%	5%
1030	14%	1%	1%	0%	0%	15%	15%
1032	6%	2%	2%	0%	0%	8%	8%
1033	3%	2%	0%	0%	0%	5%	3%
1035	3%	1%	1%	0%	0%	4%	4%
1036	3%	2%	0%	0%	0%	5%	3%
1037	3%	1%	1%	0%	0%	4%	4%
1038	3%	2%	2%	0%	0%	5%	5%
1040	13%	2%	2%	0%	0%	15%	15%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
1044	9%	1%	1%	0%	0%	10%	10%
1045	11%	2%	2%	0%	0%	13%	13%
1047	4%	2%	2%	0%	0%	6%	6%
1050	3%	2%	2%	0%	0%	5%	5%
1053	15%	2%	2%	0%	0%	17%	17%
1054	9%	1%	1%	0%	0%	10%	10%
1055	3%	1%	1%	0%	0%	4%	4%
1057	3%	2%	0%	0%	0%	5%	3%
1058	3%	1%	1%	0%	0%	4%	4%
1059	11%	2%	2%	0%	0%	13%	13%
1061	11%	2%	2%	0%	0%	13%	13%
1063	14%	2%	2%	0%	0%	16%	16%
1067	4%	2%	2%	0%	0%	6%	6%
1068	3%	2%	2%	0%	0%	5%	5%
1069	3%	2%	0%	0%	0%	5%	3%
1070	3%	2%	2%	0%	0%	6%	6%
1071	14%	2%	0%	0%	0%	16%	14%
1072	3%	2%	0%	0%	0%	5%	3%
1074	5%	2%	2%	0%	0%	7%	7%
1075	3%	1%	0%	0%	0%	4%	3%
1076	11%	1%	0%	0%	0%	12%	11%
1078	3%	2%	2%	0%	0%	5%	5%
1079	16%	1%	1%	0%	0%	17%	17%
1080	10%	2%	2%	0%	0%	12%	12%
1081	3%	1%	1%	0%	0%	4%	4%
1083	8%	1%	1%	0%	0%	9%	9%
1086	5%	2%	2%	0%	0%	7%	7%
1087	8%	2%	2%	0%	0%	10%	10%
1088	15%	1%	1%	0%	0%	16%	16%
1089	15%	2%	2%	0%	0%	17%	17%
1091	3%	1%	1%	0%	0%	4%	4%
1092	15%	2%	2%	0%	0%	17%	17%
1093	8%	2%	0%	0%	0%	10%	8%
1094	15%	1%	0%	0%	0%	16%	15%
1095	4%	2%	2%	0%	0%	6%	6%
1097	14%	2%	2%	0%	0%	16%	16%
1098	13%	1%	1%	0%	0%	14%	14%
1099	11%	1%	1%	0%	0%	12%	12%
1102	3%	1%	1%	0%	0%	4%	4%
1103	3%	1%	1%	0%	0%	4%	4%
1104	4%	2%	2%	0%	0%	6%	6%
1105	4%	1%	1%	0%	0%	5%	5%
1106	3%	1%	1%	0%	0%	4%	4%
1107	3%	2%	0%	0%	0%	5%	3%
1108	11%	1%	1%	0%	0%	12%	12%
1109	6%	2%	2%	0%	0%	8%	8%
1110	4%	2%	2%	0%	0%	6%	6%
1111	4%	1%	1%	0%	0%	5%	5%
1112	4%	2%	2%	0%	0%	6%	6%
1113	6%	2%	2%	0%	0%	8%	8%
1114	12%	1%	1%	0%	0%	13%	13%
1116	13%	2%	2%	0%	0%	15%	15%
1117	11%	2%	0%	0%	0%	13%	11%
1118	4%	2%	2%	0%	0%	6%	6%
1119	7%	2%	2%	0%	0%	9%	9%
1121	9%	2%	2%	0%	0%	11%	11%
1122	3%	2%	2%	0%	0%	5%	5%
1123	3%	2%	0%	0%	0%	5%	3%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
1124	7%	2%	2%	0%	0%	9%	9%
1126	4%	2%	2%	0%	0%	6%	6%
1128	3%	2%	2%	0%	0%	5%	5%
1130	3%	2%	2%	0%	0%	5%	5%
1131	7%	1%	1%	0%	0%	8%	8%
1132	6%	2%	2%	0%	0%	8%	8%
1133	11%	2%	0%	0%	0%	13%	11%
1134	11%	2%	2%	0%	0%	13%	13%
1136	15%	2%	2%	0%	0%	17%	17%
1139	15%	2%	2%	0%	0%	18%	18%
1142	15%	2%	0%	0%	0%	17%	15%
1143	5%	2%	2%	0%	0%	7%	7%
1144	13%	2%	2%	0%	0%	15%	15%
1145	9%	2%	2%	1%	1%	11%	11%
1146	15%	2%	0%	0%	0%	17%	15%
1147	13%	2%	2%	0%	0%	15%	15%
1148	12%	2%	2%	0%	0%	15%	15%
1149	15%	2%	0%	0%	0%	17%	15%
1150	15%	2%	0%	0%	0%	17%	15%
1151	15%	2%	0%	0%	0%	17%	15%
1152	15%	2%	2%	0%	0%	17%	17%
1153	15%	1%	0%	0%	0%	16%	15%
1154	16%	2%	2%	0%	0%	18%	18%
1155	15%	2%	0%	0%	0%	17%	15%
1156	10%	2%	0%	0%	0%	12%	10%
1157	4%	2%	0%	0%	0%	6%	4%
1158	12%	2%	2%	0%	0%	14%	14%
1160	15%	2%	2%	0%	0%	17%	17%
1161	12%	2%	2%	0%	0%	14%	14%
1163	8%	2%	2%	0%	0%	10%	10%
1164	5%	1%	0%	0%	0%	6%	5%
1166	15%	2%	2%	1%	1%	17%	17%
1167	3%	1%	0%	0%	0%	4%	3%
1170	15%	1%	0%	0%	0%	16%	15%
1171	15%	2%	0%	0%	0%	17%	15%
1172	9%	1%	1%	0%	0%	10%	10%
1173	16%	1%	1%	0%	0%	17%	17%
1174	13%	2%	2%	0%	0%	15%	15%
1175	15%	1%	1%	0%	0%	16%	16%
1176	3%	2%	2%	0%	0%	5%	5%
1178	5%	1%	1%	0%	0%	6%	6%
1179	11%	2%	2%	0%	0%	13%	13%
1180	3%	1%	1%	0%	0%	4%	4%
1181	3%	1%	1%	0%	0%	4%	4%
1182	3%	2%	0%	0%	0%	5%	3%
1183	14%	1%	1%	0%	0%	15%	15%
1184	8%	2%	2%	0%	0%	10%	10%
1185	12%	2%	2%	0%	0%	14%	14%
1186	8%	2%	2%	0%	0%	10%	10%
1187	6%	1%	1%	0%	0%	7%	7%
1188	3%	2%	2%	0%	0%	5%	5%
1189	4%	2%	2%	0%	0%	6%	6%
1190	3%	2%	2%	0%	0%	5%	5%
1191	3%	2%	0%	0%	0%	5%	3%
1192	3%	2%	2%	0%	0%	5%	5%
1193	7%	1%	1%	0%	0%	8%	8%
1197	3%	1%	0%	0%	0%	4%	3%
1198	8%	2%	2%	0%	0%	10%	10%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
1200	16%	2%	2%	0%	0%	18%	18%
1201	15%	2%	0%	0%	0%	17%	15%
1202	3%	1%	1%	0%	0%	4%	4%
1203	7%	2%	2%	0%	0%	9%	9%
1204	5%	2%	0%	0%	0%	7%	5%
1205	13%	2%	2%	0%	0%	15%	15%
1206	13%	2%	2%	0%	0%	15%	15%
1207	13%	2%	2%	0%	0%	15%	15%
1208	13%	2%	2%	0%	0%	15%	15%
1209	13%	2%	2%	0%	0%	15%	15%
330A	3%	10%	10%	0%	0%	13%	13%
330B	7%	10%	10%	4%	4%	21%	21%
339A	4%	10%	10%	0%	0%	13%	13%
339B	3%	10%	10%	0%	0%	13%	13%
350A	4%	3%	3%	0%	0%	7%	7%
350B	3%	3%	3%	0%	0%	6%	6%
350C	3%	3%	3%	0%	0%	6%	6%
353A	3%	3%	3%	0%	0%	6%	6%
353B	3%	3%	3%	0%	0%	6%	6%
362A	4%	10%	10%	2%	2%	15%	15%
362B	4%	10%	10%	0%	0%	13%	13%
368A	4%	10%	10%	1%	1%	14%	14%
368B	3%	10%	10%	1%	1%	14%	14%
385A	4%	10%	10%	1%	1%	14%	14%
385B	8%	10%	10%	0%	0%	17%	17%
386A	3%	8%	8%	0%	0%	11%	11%
386B	3%	8%	8%	0%	0%	11%	11%
388A	3%	10%	10%	0%	0%	13%	13%
388B	3%	10%	10%	0%	0%	13%	13%
388C	3%	10%	10%	0%	0%	13%	13%
389A	4%	10%	10%	0%	0%	13%	13%
389B	3%	10%	10%	0%	0%	13%	13%
389C	3%	10%	10%	0%	0%	13%	13%
390A	3%	10%	10%	0%	0%	13%	13%
390B	3%	10%	10%	0%	0%	13%	13%
396A	7%	10%	10%	0%	0%	16%	16%
396B	3%	10%	10%	0%	0%	13%	13%
398A	3%	10%	10%	0%	0%	13%	13%
398B	4%	10%	10%	0%	0%	13%	13%
420A	11%	10%	10%	0%	0%	21%	21%
420B	13%	10%	10%	0%	0%	22%	22%
420C	13%	10%	10%	0%	0%	23%	23%
424A	3%	10%	10%	3%	3%	16%	16%
424B	3%	10%	10%	1%	1%	14%	14%
430A	4%	3%	3%	0%	0%	7%	7%
430B	4%	3%	3%	0%	0%	7%	7%
430C	3%	3%	3%	0%	0%	7%	7%
430D	11%	10%	10%	0%	0%	21%	21%
439A	3%	3%	3%	0%	0%	6%	6%
439B	3%	3%	3%	0%	0%	6%	6%
441A	3%	10%	10%	0%	0%	13%	13%
441B	3%	10%	10%	0%	0%	13%	13%
448A	4%	10%	10%	0%	0%	13%	13%
448B	3%	10%	10%	1%	1%	13%	13%
454A	3%	10%	10%	0%	0%	13%	13%
459A	3%	10%	10%	1%	1%	14%	14%
459B	3%	10%	10%	0%	0%	13%	13%
459C	3%	10%	10%	0%	0%	13%	13%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
459D	3%	10%	10%	0%	0%	13%	13%
461A	3%	10%	10%	0%	0%	13%	13%
461B	8%	10%	10%	1%	1%	18%	18%
461C	3%	10%	10%	0%	0%	13%	13%
462A	3%	10%	10%	0%	0%	13%	13%
462B	5%	10%	10%	0%	0%	14%	14%
467A	13%	10%	10%	1%	1%	23%	23%
467B	4%	10%	10%	1%	1%	15%	15%
470A	3%	10%	10%	0%	0%	13%	13%
470B	6%	10%	10%	0%	0%	16%	16%
475A	4%	3%	3%	0%	0%	7%	7%
475B	3%	3%	3%	0%	0%	6%	6%
479A	6%	8%	8%	1%	1%	14%	14%
479B	15%	8%	8%	0%	0%	23%	23%
480A	3%	3%	3%	0%	0%	6%	6%
480B	4%	3%	3%	0%	0%	7%	7%
481A	4%	10%	10%	0%	0%	13%	13%
481B	13%	10%	10%	0%	0%	23%	23%
481C	5%	10%	10%	0%	0%	15%	15%
486A	3%	10%	10%	0%	0%	13%	13%
486B	11%	10%	10%	0%	0%	20%	20%
487A	14%	3%	3%	0%	0%	17%	17%
487B	8%	3%	3%	0%	0%	11%	11%
488A	5%	3%	3%	0%	0%	8%	8%
488B	4%	3%	3%	0%	0%	7%	7%
490A	15%	3%	3%	0%	0%	18%	18%
490B	10%	3%	3%	0%	0%	13%	13%
497A	9%	10%	10%	0%	0%	19%	19%
497B	3%	10%	10%	0%	0%	13%	13%
497C	8%	10%	10%	0%	0%	18%	18%
500A	4%	3%	3%	0%	0%	7%	7%
500B	3%	3%	3%	0%	0%	6%	6%
503A	13%	8%	8%	0%	0%	20%	20%
503B	13%	8%	8%	1%	1%	21%	21%
503C	15%	8%	8%	0%	0%	23%	23%
504A	12%	8%	8%	0%	0%	20%	20%
504B	15%	8%	8%	0%	0%	22%	22%
504C	15%	8%	8%	0%	0%	23%	23%
504D	3%	8%	8%	0%	0%	11%	11%
506A	11%	8%	8%	0%	0%	18%	18%
506B	8%	8%	8%	0%	0%	16%	16%
506C	13%	8%	8%	0%	0%	21%	21%
509A	12%	10%	10%	0%	0%	21%	21%
509B	4%	10%	10%	1%	1%	14%	14%
514A	3%	10%	10%	1%	1%	14%	14%
514B	8%	10%	10%	0%	0%	18%	18%
515A	14%	10%	10%	1%	1%	24%	24%
515B	3%	10%	10%	1%	1%	14%	14%
516A	15%	10%	10%	0%	0%	25%	25%
516B	11%	10%	10%	0%	0%	21%	21%
517A	12%	10%	10%	0%	0%	22%	22%
517B	8%	10%	10%	0%	0%	18%	18%
518A	15%	10%	10%	0%	0%	25%	25%
518B	15%	10%	10%	0%	0%	25%	25%
522A	15%	10%	10%	0%	0%	25%	25%
522B	15%	10%	10%	3%	3%	27%	27%
522C	15%	10%	10%	0%	0%	25%	25%
522D	15%	10%	10%	1%	1%	25%	25%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
522E	11%	10%	10%	0%	0%	21%	21%
527A	4%	10%	10%	3%	3%	16%	16%
527B	4%	10%	10%	0%	0%	14%	14%
527C	3%	10%	10%	1%	1%	14%	14%
527D	3%	10%	10%	2%	2%	15%	15%
528A	3%	3%	3%	0%	0%	6%	6%
528B	12%	10%	10%	0%	0%	21%	21%
529A	6%	10%	10%	0%	0%	16%	16%
529B	8%	10%	10%	1%	1%	18%	18%
529C	13%	10%	10%	0%	0%	23%	23%
530A	12%	10%	10%	2%	2%	23%	23%
530B	6%	10%	10%	0%	0%	16%	16%
535A	13%	10%	10%	0%	0%	22%	22%
535B	12%	10%	10%	0%	0%	21%	21%
540A	8%	10%	10%	1%	1%	19%	19%
540B	11%	10%	10%	0%	0%	20%	20%
543A	7%	10%	10%	0%	0%	17%	17%
543B	15%	10%	10%	0%	0%	25%	25%
547A	15%	10%	10%	0%	0%	25%	25%
547B	15%	10%	10%	0%	0%	25%	25%
547C	15%	10%	10%	0%	0%	25%	25%
547D	15%	10%	10%	0%	0%	25%	25%
549A	15%	3%	3%	0%	0%	18%	18%
549B	15%	3%	3%	0%	0%	18%	18%
551A	15%	10%	10%	1%	1%	25%	25%
551B	15%	10%	10%	1%	1%	26%	26%
551C	15%	10%	10%	0%	0%	25%	25%
551D	15%	10%	10%	0%	0%	25%	25%
552A	14%	10%	10%	0%	0%	23%	23%
552B	3%	10%	10%	2%	2%	15%	15%
554A	5%	10%	10%	0%	0%	14%	14%
558A	15%	3%	3%	0%	0%	18%	18%
562A	15%	10%	10%	1%	1%	25%	25%
562B	10%	10%	10%	0%	0%	20%	20%
562C	3%	10%	10%	1%	1%	14%	14%
564A	15%	10%	10%	0%	0%	25%	25%
564B	15%	10%	10%	0%	0%	25%	25%
564C	14%	10%	10%	0%	0%	24%	24%
565A	4%	3%	3%	1%	1%	8%	8%
565B	3%	3%	3%	3%	3%	9%	9%
566A	3%	10%	10%	0%	0%	13%	13%
566B	3%	10%	10%	0%	0%	13%	13%
567A	3%	10%	10%	0%	0%	13%	13%
567B	3%	10%	10%	0%	0%	13%	13%
568A	15%	10%	10%	0%	0%	24%	24%
568B	10%	10%	10%	0%	0%	19%	19%
570A	4%	10%	10%	0%	0%	13%	13%
570B	10%	10%	10%	0%	0%	19%	19%
573A	5%	10%	10%	0%	0%	15%	15%
573B	4%	10%	10%	0%	0%	13%	13%
574A	4%	10%	10%	0%	0%	14%	14%
574B	4%	10%	10%	0%	0%	13%	13%
574C	7%	10%	10%	0%	0%	16%	16%
574D	8%	10%	10%	0%	0%	18%	18%
574E	5%	10%	10%	0%	0%	14%	14%
577A	6%	3%	3%	0%	0%	9%	9%
577B	3%	3%	3%	0%	0%	6%	6%
580A	5%	10%	10%	0%	0%	15%	15%

Unit	Existing Condition DSC Percent	Vegetation Treatments		Temporary Roads		Cumulative DSC Percent	
580B	6%	10%	10%	0%	0%	15%	15%
581A	4%	10%	10%	0%	0%	14%	14%
581B	3%	10%	10%	0%	0%	13%	13%
581C	9%	10%	10%	0%	0%	19%	19%

Table 9 display the total acres of detrimental soil conditions expected from the proposed activities. The action alternatives are designed to reduce the amount of detrimental soil conditions by implementing the project design features described in Chapter 2.

Table 9. Detrimental Soil Conditions by Alternatives

Description	Alternative 2	Alternative 3
Acres of DSC from Past Activities	3,930	3,930
Acres of DSC from Proposed Activities	2,375	2,370
Acres of Cumulative DSC	6,300	6,295

Restoration efforts would be undertaken in units where DSCs are expected to exceed 20 percent. Restoration activities to improve soil conditions would include ripping heavily used skid trails and landings. The goal would be to reduce soil compaction and meet the direction provided in Region 6 Supplement 2500-98-1. Several studies discuss the effectiveness of ripping as a soil restoration activity. Seedling survival and growth can be improved by 39 percent after tilling of compacted soils (Froehlich et al., 1983).

Subsoiling restores biological processes that are reduced by soil compaction (Dick et al., 1988). In general, tilling or scarifying a compacted soil improves productivity by reducing the resistance of soil to root penetration and providing improved soil drainage and aeration to enhance seedling establishment and tree growth (Bulmer, 1998). These conditions also improve the environment for soil microorganisms. Soil restoration is not the immediate result of ripping, planting or any other activity. The goal of soil restoration is to create favorable conditions for impaired soils to begin the recovery process.

Duration of Effects

Displacement and erosion, the loss of topsoil, is a long-term and perhaps a permanent loss of soil productivity. However, management practices outline in the Design Criteria would reduce the occurrence of displacement and erosion to within the Region 6 Soil Quality Standards and Guidelines.

Compaction may last from 10 to 70 years (Gonsior, 1983). Monitoring of 40-year old activities within this project area averaged between 3 and 15 percent DSC, indicating recovery of compacted soils has occurred.

Reductions in organic matter content reverse quickly as vegetation is established. Organic debris accumulates on the surface and roots grow and are decomposed in the soil. These organic materials break down and release nutrients and improve the quality of the soil by improving its structure and reducing compaction and other DSCs. Loss of organic matter is a short-term change lasting about 10 years once vegetation returns to the soil.

Light and moderate severity burned areas have minor effects well within the natural range of variability for wildfire. Areas burned under conditions that produce light or moderate burn severity would vegetate quickly due to viable seeds or roots that could produce more plants and the complement of microorganisms and nutrients remaining on site (Ryan and Noste, 1985).

Changes in soil microorganisms are not permanent. Recovery would occur as soon as organic matter is present in the soil, which could be immediately after the proposed management is carried out.

Soil erosion would be controlled through the use of erosion control measures. In addition, bare soils would naturally recover or be re-vegetated with native seed. Any erosion that occurs would be short-lived, most likely occurring during the time between the soil disturbance and the implementation of erosion control measures.

SUMMARY

SUMMARY OF ENVIRONMENTAL EFFECTS

Table 10. Summary of Indicators and Measures by Alternative

Resource Element	Indicator	Measure	Alternative 1	Alternative 2	Alternative 3
Soil Productivity	Detrimental Soil Conditions	Acres of total detrimental soil conditions	3,930	6,300	6,295
	Droughty Soils	Acres of droughty soil types treated	0	21,880	19,298
Soil Erosion	Erosion Potential	Tons/acre of hillslope erosion modeled from WEPP	0	0.14	0.09
		Acres of soils with high/very high erosion potential	20,144	11,074	9,771
		Miles of temporary roads on high erosion potential soil	0	26	26
Slope Stability	Landslide Potential	Acres of slopes with high landslide potential or existing landslides	1,685	1,651	1,511
		Miles of temporary roads on slopes with high landslide potential or existing landslides	0	5	5

COMPLIANCE WITH LRMP AND OTHER RELEVANT LAWS, REGULATIONS, POLICIES AND PLANS

The Organic Administration Act of 1897 authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests "...to improve and protect the forest within the boundaries, or for the purposed of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States." The project would ensure continued water flows and productive lands that ensure a continuous supply of timber through implementation of BMPs and PDCs. The Bankhead-Jones Farm Tenant Act of 1937 authorizes and directs a program of land conservation and land utilization, in order to correct maladjustments in land use, and thus assist in controlling soil erosion, preserving natural resources, mitigating floods, conserving

surface and subsurface moisture, protecting the watershed of navigable streams, and protecting the public lands, health, safety, and welfare. The project would comply with The Bankhead-Jones Farm Tenant Act by ensuring we are mitigating soil erosion, preserving natural resources, and conserving surface and subsurface moisture through implementation of BMPs and PDCs. The project, with described mitigations and BMPs in place, would meet the intent and direction of the Multi-Use Sustained Yield Act of 1960. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

The NFMA requires that Forest Service regulations implementing NFMA specify guidelines to ensure that timber will be harvested from NFS lands only where “soil, slope, or other watershed conditions will not be irreversibly damaged.” 16 USC 1604 (g)(3)(E)(i). Region 6 Soil Quality Standards identified as FSM R-6 Supplement 2500-98-1 were set forth to meet the direction of NFMA to manage NFS lands without permanent impairment of land productivity and to maintain or improve soil quality. In addition, NFMA amends section 18 of Knutson-Vandenberg Act (KV). This amendment authorizes the use of KV funds to protect and improve the future productivity of the renewable resources of the National Forests, including soil and water. This project will prioritize KV funds for rehabilitation of temporary roads created on non-system historic road templates that are only required to be returned to existing condition after use (Soil PDC 14). The project complies with 36 CFR 219.20, which requires conservation and protection of soil and water resources. Regional guidance is available from the Region 6 FSM for Watershed Protection and Management 2500-98-1. Regional policy states:

“Design new activities that do not exceed detrimental soil conditions on more than 20 percent of an activity area. (This includes the permanent transportation system). In areas where less than 20 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 20 percent. In areas where more than 20 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration must, at a minimum, not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.”

National BMPs and design criteria included in this project for alternatives 2 and 3, ensure that proposed activities will meet all relevant laws mentioned above. Forest Plan standards for the Wallowa-Whitman National Forest will be met in this project as seen below in Table 11.

Table 11. Forest Plan Compliance

Forest Plan Standard	Subject Summary	Compliance Achieved By
WAW (p.4-21)	Give maintenance of soil productivity and stability priority over uses described or implied in all other management direction, standards, or guidelines.	<ul style="list-style-type: none"> • Soil type identification and evaluation • Field surveys and office evaluations conducted on a representative group of the proposed Activity Areas • Prioritize soil quality and stability over all other management objectives
WAW (p.4-21)	Protection of soil productivity. A minimum of 80% of an Activity Area shall not be detrimentally compacted, displaced, or puddled upon completion of activities.	<ul style="list-style-type: none"> • Emphasize protection over restoration • Soil improvement activities on areas with prior impacts to maintain or improve soil productivity • Provide contract recommendations to limit impact and aerial extent of disturbance from proposed activities
WAW (p.4-	Special consideration, protection and mitigation for	<ul style="list-style-type: none"> • Identify and provide PDCs that avoid and protect shallow soils during project implementation

21)	shallow soils.	
WAW (p.4-21)	Maintain adequate ground cover to minimize soil loss from surface erosion and mass wasting.	<ul style="list-style-type: none"> • Project design features developed to minimize erosion • Project design features developed to maintain the minimum percent effective ground cover after any soil-disturbing activity based on erosion hazard class • Temporary road locations will be evaluated during implementation. In landslide susceptible areas, unit-specific design measures were developed.

OTHER RELEVANT MANDATORY DISCLOSURES

INTENSITY FACTORS FOR SIGNIFICANCE (FONSI) (40 CFR 1508.27(B))

3. Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

There are wetlands present in the project area. Wetlands are considered to be a sensitive soil type, however seeps, springs, and wetlands would have the INFISH buffer designation and special project design criteria described in alternatives 2 and 3 to ensure protection. Therefore, the effects of the proposed actions to these sensitive soil types do not rise to the level of significance for intensity factor three.

5. The degree to which the possible effects on the human environment highly uncertain or involve unique or unknown risks.

These areas were assessed with a Level 1 Slope Stability Assessment by Region 6 Geotechnical engineers and their report and recommendations can be found in the project file (Project File Exhibit E). This assessment provided the planning team with possible risks and recommendations to ensure all proposed activities within historic landslides or landslide prone areas will not create uncertain, unique or unknown risks to the human environment.

10. Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

Relevant laws and requirements include the Wallowa-Whitman Forest Plan, Organic Administration Act of 1897, Bankhead-Jones Act of 1937, The Multiple Use-Sustained Yield Act of 1960, 36 CFR 219.20, The National Forest Management Act of 1976, FSM 2500 Watershed and Air Management, and Region 6 Soil Quality Standards. Project design criteria and BMPs would prevent significant effects to the soil resource. For this reason, the proposed action is consistent with the above laws and requirements, and it does not rise to the level of significance for intensity factor ten.

OTHER AGENCIES AND INDIVIDUALS CONSULTED

Bill Burns, Geological Engineer at Oregon Department of Geology and Mineral Industries (DOGAMI) was consulted to discuss slope stability on the 1040 road within the project area on October 24, 2018

Rene Renteria, Angelica Perez-Delgado, and Michael Chin, Geotechnical Engineers at USDA Forest Service were consulted and completed a Level 1 Slope Stability Site Assessment and Evaluation on June 5, 2019

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